

MODIS DATA STUDY TEAM PRESENTATION

September 14, 1990

AGENDA

1. Action Items
2. MODIS Level-1 Processing System Design Presentation to the MODIS Science Team
3. A Proposed Universal MODIS Header
4. Preliminary MODIS Level-1 Processing System Design Context and Data Flow Diagrams and Data Dictionary (DRAFT; under separate cover).

8/10/90-1 [John Barker]: Specify data requirements for the MCST Support Products (at Level-1A and Level-1B). STATUS: Open.

8/10/90-2 [Al McKay]: Clarify data flow requirements between the ICC and the Level-1 Processing. STATUS: Level-1 processing flows under development; ICC-PGF interface still pending.

8/31/90-1 [Daesoo Han]: Invite Tom Taylor to attend the next MODIS Data Study Team Meeting to discuss the EOSDIS Core System concept. STATUS: Closed 8/31/90.

PRELIMINARY MODIS LEVEL-1 PROCESSING SYSTEM DESIGN

FIRST DRAFT

September 12, 1990

- I. Presentation to the MODIS Science Team**
- II. Context and Data Flow Diagrams**
- III. Data Dictionary**

MODIS LEVEL-1 PROCESSING SYSTEM DESIGN PRESENTATION TO THE MODIS SCIENCE TEAM

DRAFT

1. DESIGN GENERALITY

The MODIS Level-1 processing software design is general to the extent that it includes:

- MODIS-N and MODIS-T
- Partial scans due to data loss
- Processing and reprocessing
- Routine and near-real-time processing
- Standard and special processing
- Multiple instrument operating modes

2. ARCHIVE PRODUCTS

The MODIS Level-1 processing software will produce the following products for outside use and long-term archive:

- Level-1A Data
- Level-1B Data
- Level-1A Metadata (by orbit)
- Level-1B Metadata (by scene)
- Level-1B Browse (by scene)
- MCST Support Products (at Levels -1A and -1B)
- Processing Status/DQA Reports

3. LEVEL-1A FUNCTIONS

- Receives MODIS Level-0, Platform Ancillary, and Instrument Control Log data
- Assembles and organizes the data sets into scans and orbits
- Constructs and appends scan and orbital headers
- Generates Level-1A metadata
- Delivers Level-1A Data, Metadata, MCST Support Products, and Processing Status/DQA Reports

4. LEVEL-1B FUNCTIONS

- Receives MODIS Level-1A and Instrument Control Log data
- Navigates on-Earth anchor point and space-look data

- Determines calibration coefficients/model and applies counts-to-radiance conversion to all IFOVs for all bands
- Generates Level-1B metadata
- Generates Level-1B scan- and Earth-coordinate browse data
- Capable of setting flags describing scene type and cloud cover
- Delivers Level-1B Data, Metadata, Browse, MCST Support Products, and Processing Status/DQA Reports

5. LEVEL-1A DATA CONTENTS AND USE

MODIS instrument data at original resolution, time-order restored, duplicates removed, and reversible to Level-0. Platform ancillary, calibration data (if supplied), and limited other ancillary data appended. The sensor data will be in digital counts, and likely densely packed. The basic format will be as packetized by the instrument. We expect the primary uses of this product to be both long-term archival and generation of the Level-1B product.

- All available MODIS Level-0 data packets
- All relevant platform ancillary data
- All relevant instrument control log data
- Organized by scans and orbits
- Scan and orbital headers contain limited bookkeeping, ephemeris, attitude, data quality, other platform/EOS information, spares, and other TBD parameters
- Fully reversible to Level-0
- Level-1A radiometric data in packed counts form, not navigated
- Limited use by MODIS Science Team anticipated

6. LEVEL-1B DATA CONTENTS AND USE

Calibrated and navigated MODIS spectral radiances at original resolution (not reversible to Level-0) and other related platform and ground ancillary data. Little if any off-Earth instrument data (i.e., space-look, internal blackbody, etc.) will be retained at this level. We expect this product to be widely used (relative to Level-1A).

- Missing or transmission-damaged packets are filled
- Only on-Earth MODIS radiometric data calibrated and retained
- Navigation to Earth coordinates applied for sparse array of anchor points
- Not reversible to Level-0 or to Level-1A
- Organized by scans
- Scan and orbital headers contain limited bookkeeping, ephemeris, data quality, platform/other EOS information, calibration, spares, and other TBD parameters
- Described in metadata by scenes
- Browse data developed for both Earth-coordinate and scan-coordinate scenes.
- Evaluates instrument performance
- Can generate special/non-standard products on demand

7. LEVEL-1A METADATA CONTENTS AND USE

- Summarized by orbit
- Awaiting statement of requirements by the science team.

8. LEVEL-1B METADATA CONTENTS AND USE

- Summarized by scene
- Awaiting statement of requirements by the science team.

9. LEVEL-1B BROWSE CONTENTS AND USE

- Summarized by scene
- Both Earth-coordinate and scan-coordinate scenes.
- Awaiting statement of requirements by the science team.

10. MCST SUPPORT PRODUCTS CONTENTS AND USE

- MCST Support Products will be generated by both Level-1A and -1B processing steps.
- Will be composed of specified on-Earth, internal-calibration, space- and lunar-look, ancillary, and descriptive data and information.
- Product definition may be a combination of both set and varying data requirements.
- Awaiting requirements specification by the MCST.

11. MODIS SCIENCE TEAM QUESTIONS ON MODIS LEVEL-1A AND 1B DATA

The following questions serve to highlight those areas of specific interest to us:

- Does the above scenario for MODIS Level-1 processing meet your requirements?
- What are your requirements for metadata and browse data?
 - Number of bands
 - Scene sizes
 - Should Level-1B browse be georeferenced?
 - Should we have different browse formats for different modes of operation?
 - What descriptive information would you like access to for ordering purposes?

A PROPOSED UNIVERSAL MODIS HEADER

The attached pages list some potential information that could be incorporated within MODIS headers. The approach adopted is to construct a format for the headers which is compact (2 kilobits) and universal (valid for all data block sizes, both MODIS instruments, and all levels of processing). A universal header is preferable since no prior knowledge of the data content is required to read and extract the data. The list of parameters given here is a starting point for discussion and not a final version. More parameters will probably be added and the header size may expand from 2 kilobits to 3 or 4 kilobits. Thus, for example, each MODIS-T scan contains about 380 to 400 kilobits, so the proposed 2 kilobit header adds less than 1% to the data load.

A universal MODIS header is an improvement over the present situation where each geophysical parameter will have its own header format. Without any standard format, scientists will require 40 to 50 separate header reading subroutines to read the data.

POTENTIAL MODIS HEADER INFORMATION
(with estimate of bits required)

1) Bookkeeping information (184 bits)

- a) Instrument and platform name and/or ID number (8 bits)
- b) Mode(s) of operation in data block
 - 1) If single mode, mode number (8 bits)
 - 2) If multiple modes, yes/no ID (20 bits)
- c) Block type(e.g., scan, scene, orbit; 8 bits)
- d) Data product name and/or ID (8 bits)
 - 1) Processing level (8 bits)
 - 2) Processing date (24 bits)
 - 3) Processing location (8 bits)
 - 4) Level 1A algorithm version number (8 bits)
 - 5) Level 1B calibration version number (8 bits)
 - 6) Level 2 algorithm version number (8 bits)
 - 7) Level 3 algorithm version number (8 bits)
 - 8) Level 4 algorithm version number (8 bits)
- e) Data type (8 bits)
 - 1) Counts data, yes/no each band (40 bits)
 - 2) Radiance data, yes/no each band (40 bits, as counts)
 - 3) Geometry data, yes/no each type (4 bits)
 - 4) Geophysical parameter and/or its ID number (8 bits)
 - 5) Other data type (TBD bits)

2) Ephemeris information (876 bits)

- a) Day and time information
 - 1) Year (8 bits)
 - 2) Start and end day (16 bits)
 - 3) Start and end time (128 bits)
- b) Orbit number (18 bits)
- c) Nadir latitude and longitude (128 bits)
- d) Latitude/longitude and solar zenith angle information
 - 1) Maximum/minimum latitude in block (128 bits)
 - 2) Maximum/minimum longitude in block (128 bits)
 - 3) Maximum/minimum solar zenith angles (128 bits)
- e) Tilt angle (16 bits)
- f) Coordinate system/earth figure used (8 bits)
- g) Map projection type (if relevant; 8 bits)
- h) Solar/lunar information
 - 1) Earth-sun distance and/or Earth-sun distance squared (64 bits)
 - 2) Moon data in block (yes/no) (2 bits)
 - 3) Earth-moon distance and/or Earth-moon distance squared (64 bits)
 - 4) Lunar phase (16 bits)
 - 5) Lunar libration angle (16 bits)

3) Data quality information (112 bits)

- a) Percent data flagged bad
 - 1) Missing percent (16 bits)
 - 2) Unrecoverable percent (16 bits)
 - 3) Other flags TBD (32 bits)
- b) Percent of land in data block (16 bits)
- c) Percent of ocean in data block (16 bits)
- d) Percent of data block with clouds (16 bits)

4) Platform/other Eos information at start of data block (552 bits)
(also at end of block?)

- a) Platform name and/or ID (8 bits)
- b) Relevant platform ancillary data
 - 1) Platform position (96 bits)
 - 2) Platform velocity (96 bits)
 - 3) Attitude angles (36 bits)
 - 4) Attitude rates (36 bits)
 - 5) Magnetic coil currents (24 bits)
 - 6) Solar array current (8 bits)
 - 7) Solar position (24 bits)
 - 8) Lunar position (24 bits)
 - 9) Time tag (64 bits)
 - 10) GPS to UTC time conversion (32 bits)
 - 11) Spares (72 bits)
- c) Status of other instruments on platform (32 bits)

5) Spares and other TBD parameters (324 bits)

The total storage for each header is set at 2048 bits, including spares. Headers for a scan, scene, or orbit could have the same format.

PRELIMINARY MODIS LEVEL-1 PROCESSING SYSTEM DESIGN

FIRST DRAFT

September 12, 1990

- I. Presentation to the MODIS Science Team
- II. Context and Data Flow Diagrams
- III. Data Dictionary

MODIS LEVEL-1 PROCESSING SYSTEM DESIGN PRESENTATION TO THE MODIS SCIENCE TEAM

DRAFT

1. DESIGN GENERALITY

The MODIS Level-1 processing software design is general to the extent that it includes:

- MODIS-N and MODIS-T
- Partial scans due to data loss
- Processing and reprocessing
- Routine and near-real-time processing
- Standard and special processing
- Multiple instrument operating modes

2. ARCHIVE PRODUCTS

The MODIS Level-1 processing software will produce the following products for outside use and long-term archive:

- Level-1A Data
- Level-1B Data
- Level-1A Metadata (by orbit)
- Level-1B Metadata (by scene)
- Level-1B Browse (by scene)
- MCST Support Products (at Levels -1A and -1B)
- Processing Status/DQA Reports

3. LEVEL-1A FUNCTIONS

- Receives MODIS Level-0, Platform Ancillary, and Instrument Control Log data
- Assembles and organizes the data sets into scans and orbits
- Constructs and appends scan and orbital headers
- Generates Level-1A metadata
- Delivers Level-1A Data, Metadata, MCST Support Products, and Processing Status/DQA Reports

4. LEVEL-1B FUNCTIONS

- Receives MODIS Level-1A and Instrument Control Log data
- Navigates on-Earth anchor point and space-look data

- Determines calibration coefficients/model and applies counts-to-radiance conversion to all IFOVs for all bands
- Generates Level-1B metadata
- Generates Level-1B scan- and Earth-coordinate browse data
- Capable of setting flags describing scene type and cloud cover
- Delivers Level-1B Data, Metadata, Browse, MCST Support Products, and Processing Status/DQA Reports

5. LEVEL-1A DATA CONTENTS AND USE

MODIS instrument data at original resolution, time-order restored, duplicates removed, and reversible to Level-0. Platform ancillary, calibration data (if supplied), and limited other ancillary data appended. The sensor data will be in digital counts, and likely densely packed. The basic format will be as packetized by the instrument. We expect the primary uses of this product to be both long-term archival and generation of the Level-1B product.

- All available MODIS Level-0 data packets
- All relevant platform ancillary data
- All relevant instrument control log data
- Organized by scans and orbits
- Scan and orbital headers contain limited bookkeeping, ephemeris, attitude, data quality, other platform/EOS information, spares, and other TBD parameters
- Fully reversible to Level-0
- Level-1A radiometric data in packed counts form, not navigated
- Limited use by MODIS Science Team anticipated

6. LEVEL-1B DATA CONTENTS AND USE

Calibrated and navigated MODIS spectral radiances at original resolution (not reversible to Level-0) and other related platform and ground ancillary data. Little if any off-Earth instrument data (i.e., space-look, internal blackbody, etc.) will be retained at this level. We expect this product to be widely used (relative to Level-1A).

- Missing or transmission-damaged packets are filled
- Only on-Earth MODIS radiometric data calibrated and retained
- Navigation to Earth coordinates applied for sparse array of anchor points
- Not reversible to Level-0 or to Level-1A
- Organized by scans
- Scan and orbital headers contain limited bookkeeping, ephemeris, data quality, platform/other EOS information, calibration, spares, and other TBD parameters
- Described in metadata by scenes
- Browse data developed for both Earth-coordinate and scan-coordinate scenes.
- Evaluates instrument performance
- Can generate special/non-standard products on demand

7. LEVEL-1A METADATA CONTENTS AND USE

- Summarized by orbit
- Awaiting statement of requirements by the science team.

8. LEVEL-1B METADATA CONTENTS AND USE

- Summarized by scene
- Awaiting statement of requirements by the science team.

9. LEVEL-1B BROWSE CONTENTS AND USE

- Summarized by scene
- Both Earth-coordinate and scan-coordinate scenes.
- Awaiting statement of requirements by the science team.

10. MCST SUPPORT PRODUCTS CONTENTS AND USE

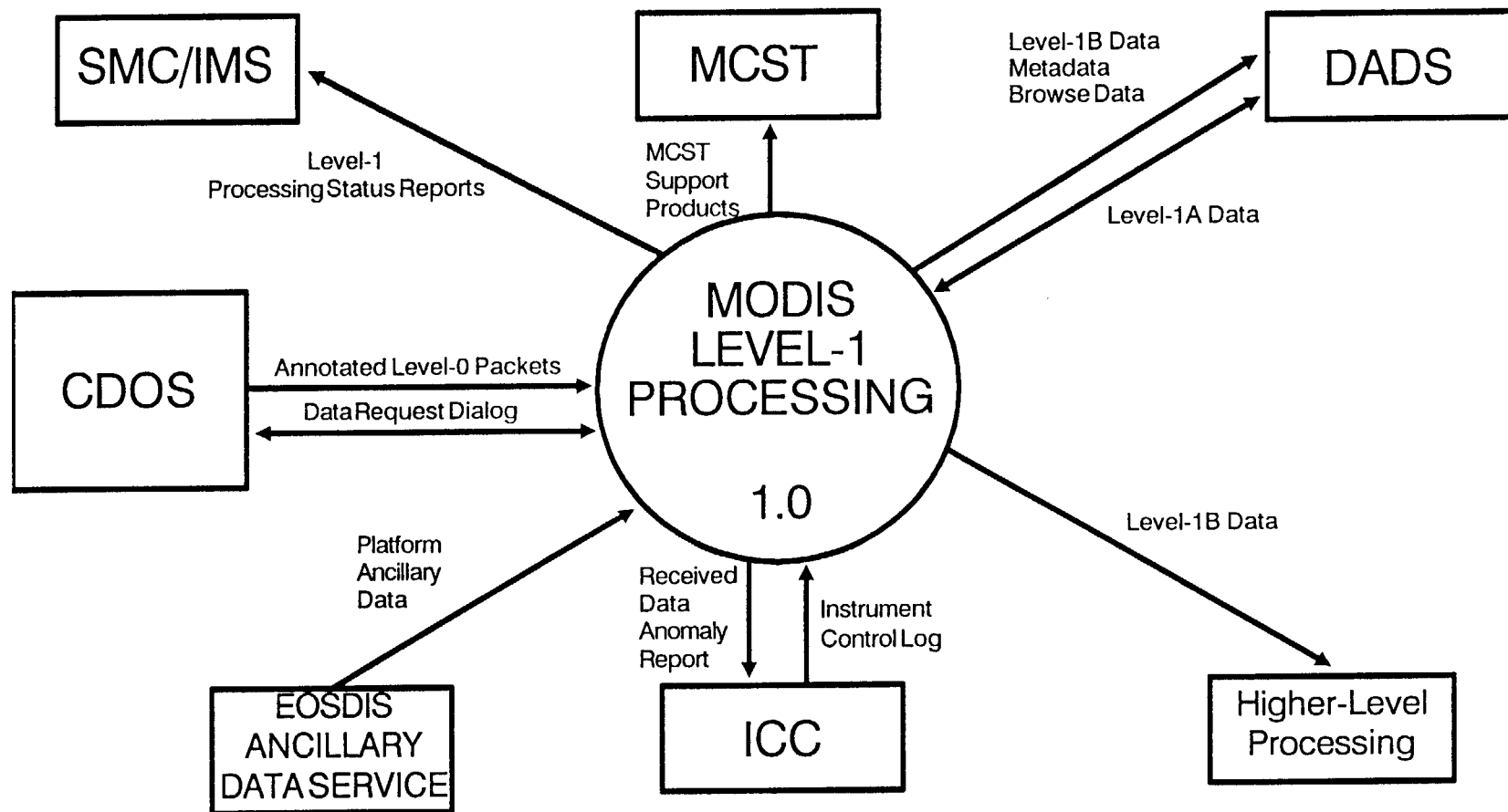
- MCST Support Products will be generated by both Level-1A and -1B processing steps.
- Will be composed of specified on-Earth, internal-calibration, space- and lunar-look, ancillary, and descriptive data and information.
- Product definition may be a combination of both set and varying data requirements.
- Awaiting requirements specification by the MCST.

11. MODIS SCIENCE TEAM QUESTIONS ON MODIS LEVEL-1A AND 1B DATA

The following questions serve to highlight those areas of specific interest to us:

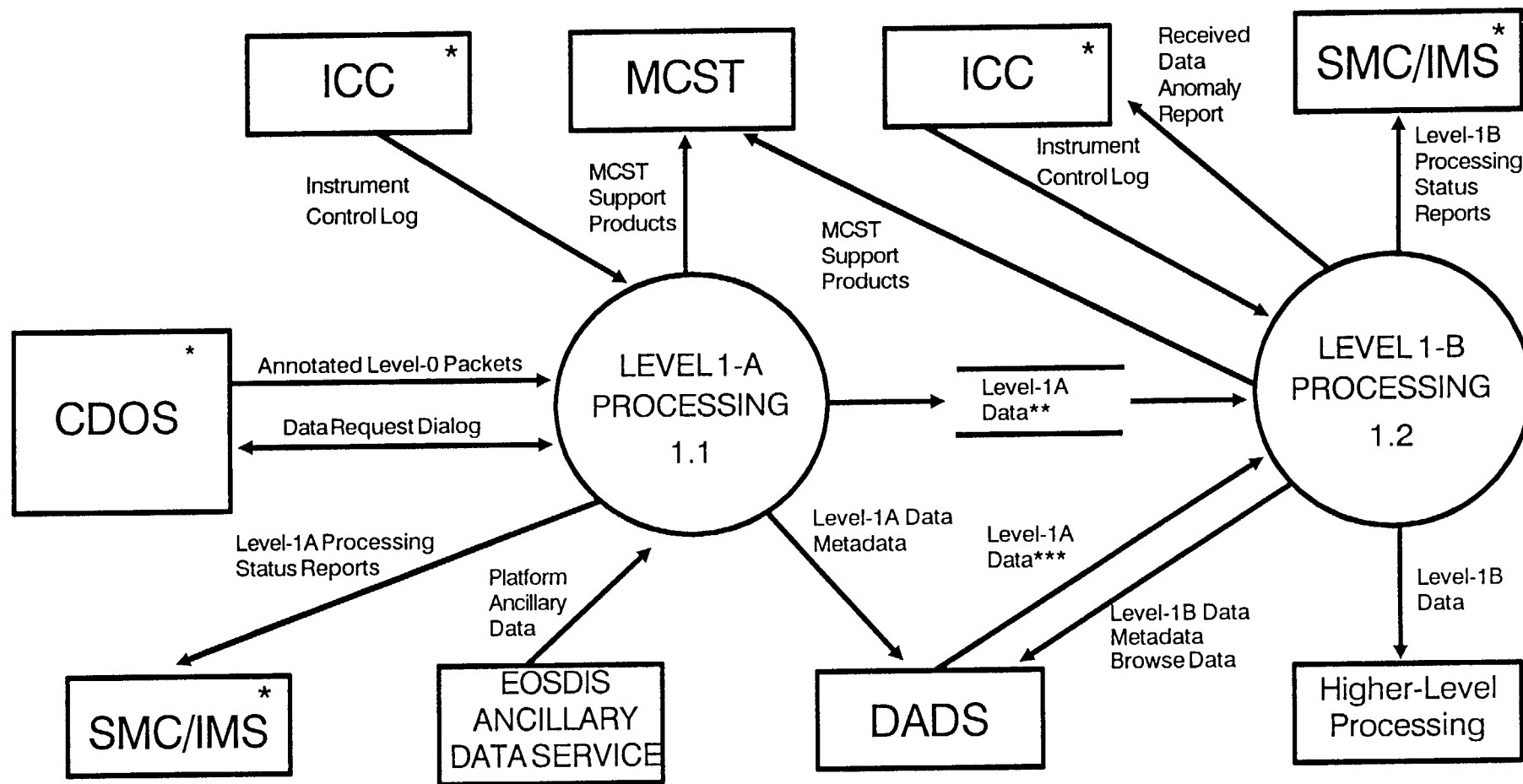
- Does the above scenario for MODIS Level-1 processing meet your requirements?
- What are your requirements for metadata and browse data?
 - Number of bands
 - Scene sizes
 - Should Level-1B browse be georeferenced?
 - Should we have different browse formats for different modes of operation?
 - What descriptive information would you like access to for ordering purposes?

MODIS LEVEL-1 PROCESSING CONTEXT DIAGRAM



September 11, 1990

MODIS LEVEL-1 PROCESSING DATA FLOW DIAGRAM (FUNCTION 1.0)



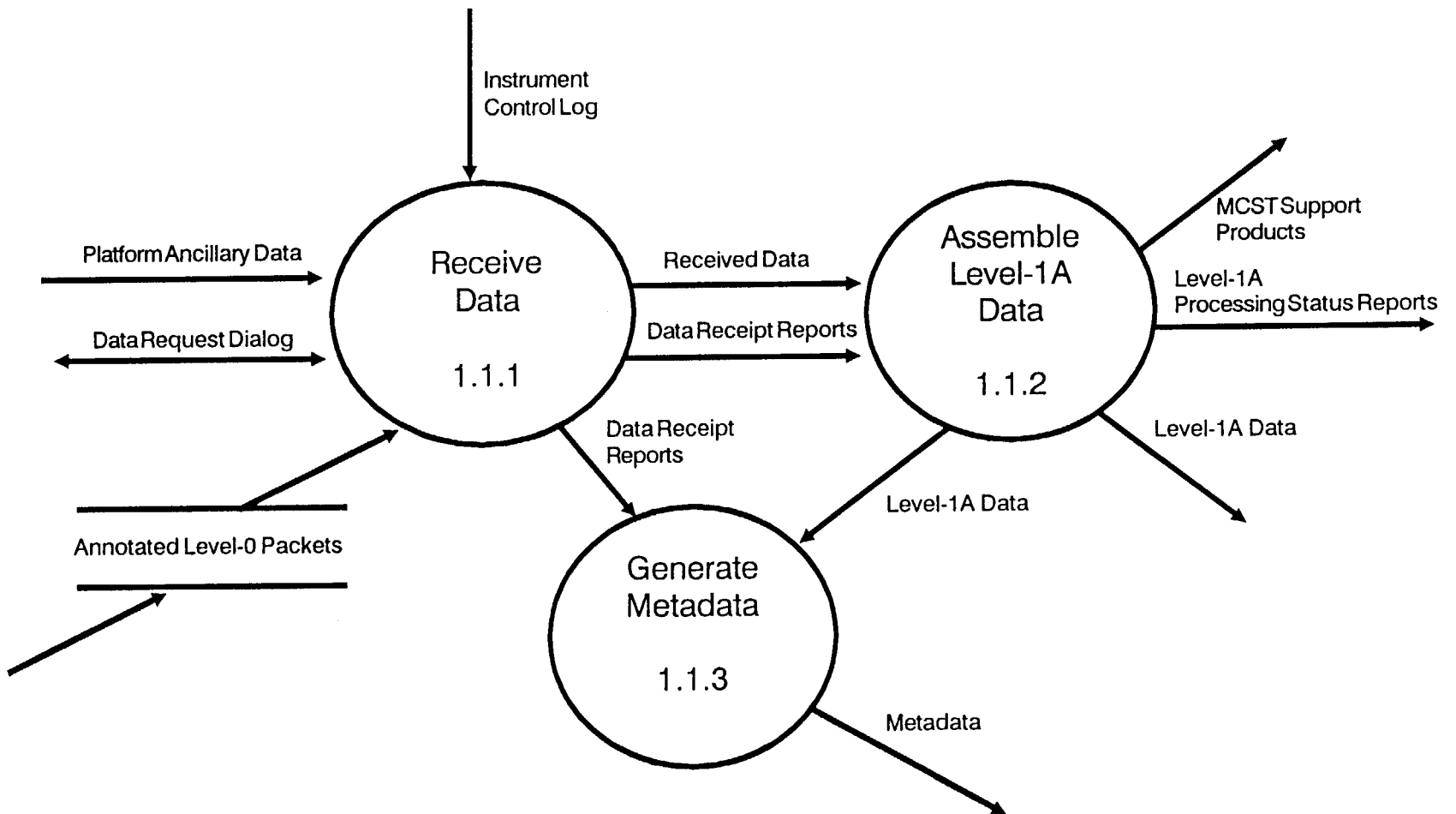
*A single asterisk indicates that an item has been repeated on the same diagram. Items are repeated for readability.

**Only following Level-1A processing or reprocessing.

***For reprocessing beginning with Level-1B (and higher) only.

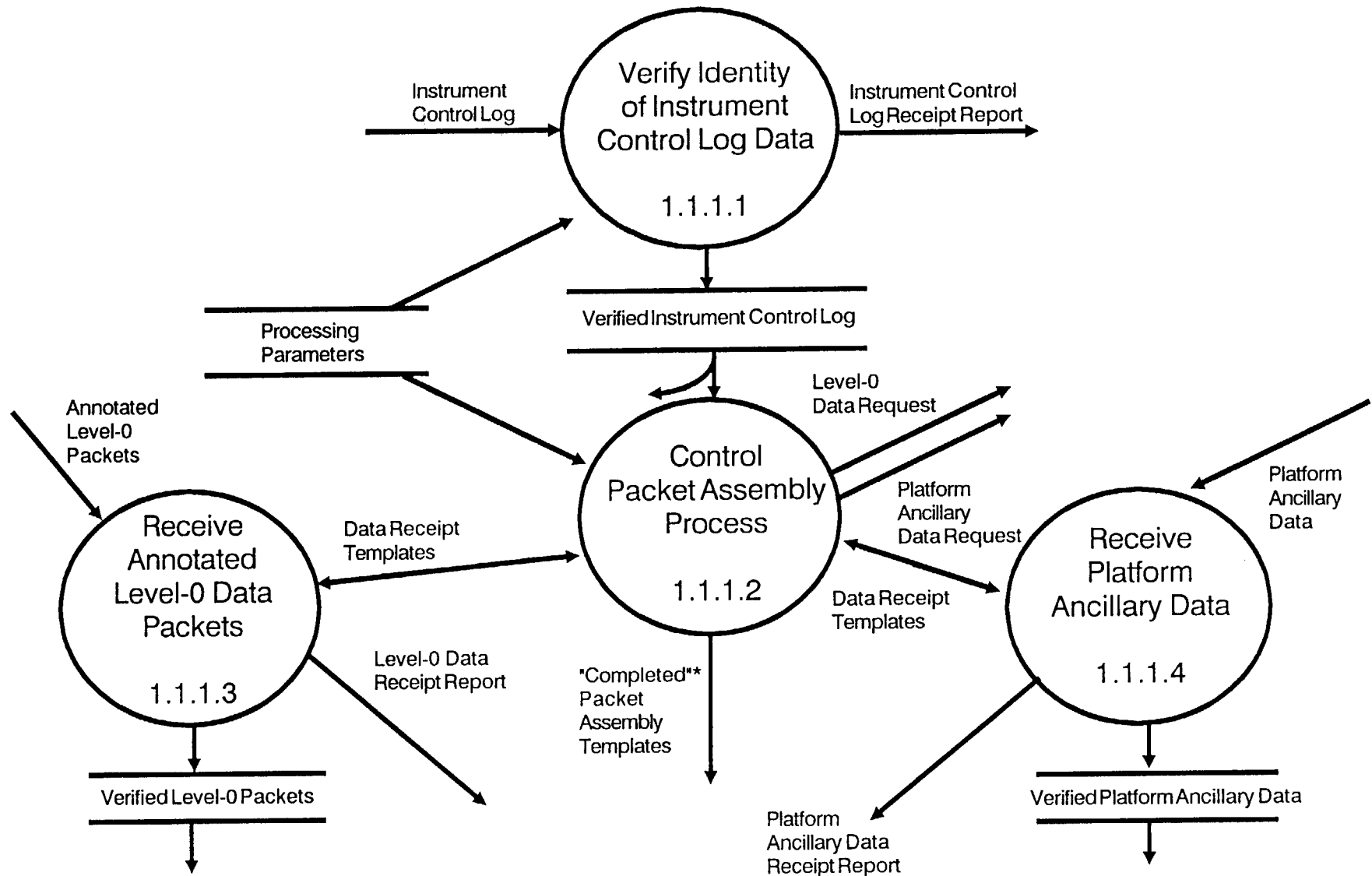
MODIS LEVEL-1A PROCESSING

DATA FLOW DIAGRAM (FUNCTION 1.1)



RECEIVE DATA

DATA FLOW DIAGRAM (FUNCTION 1.1.1)

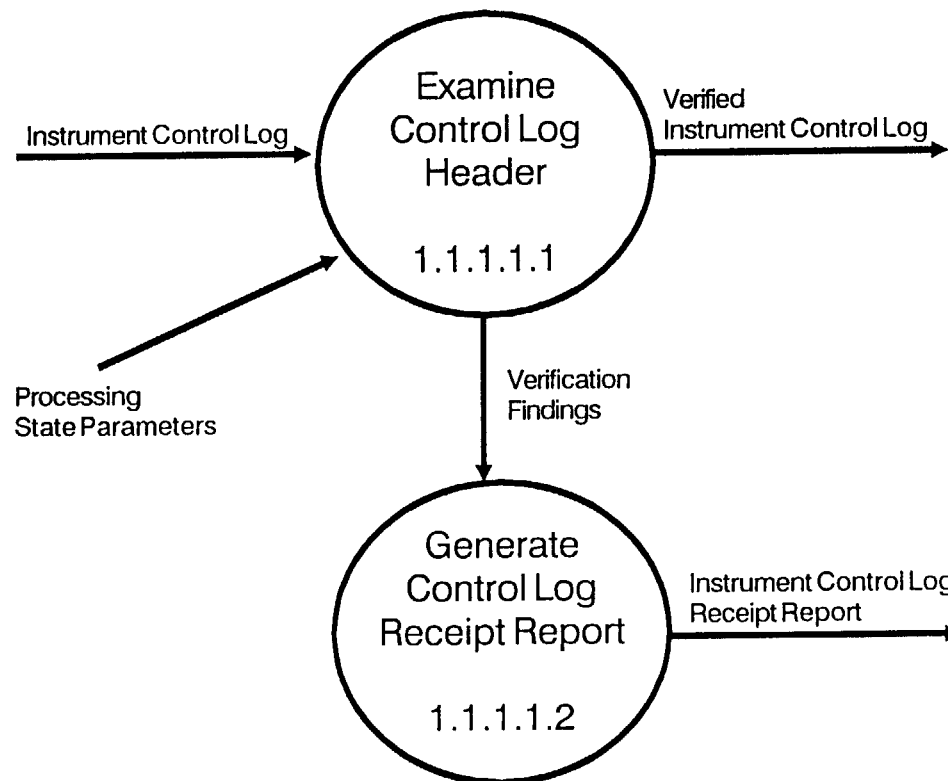


*The definition of "completeness" may be flexible and a function of elapsed time from observation.

September 10, 1990

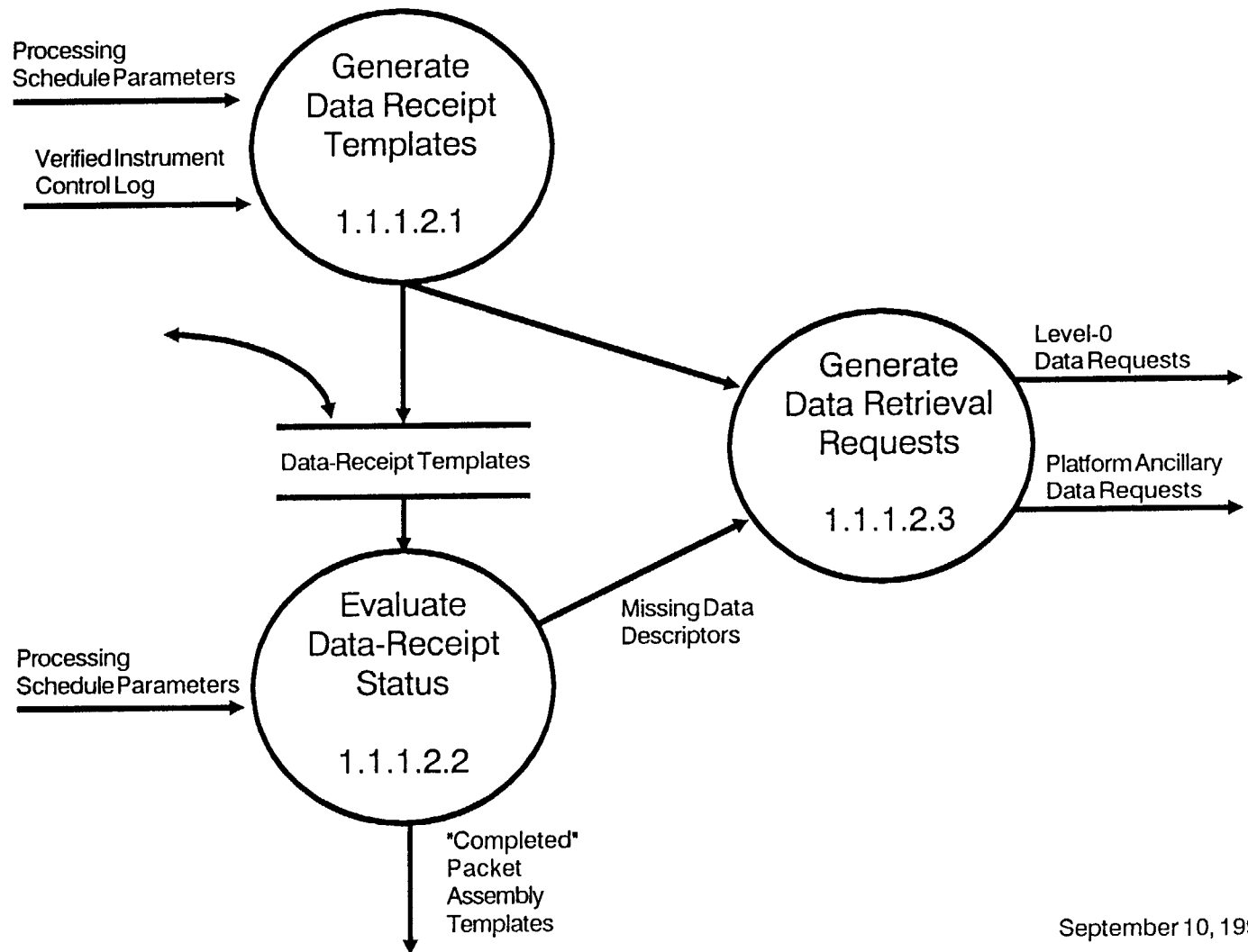
VERIFY IDENTITY OF INSTRUMENT CONTROL LOG DATA

DATA FLOW DIAGRAM (FUNCTION 1.1.1.1)



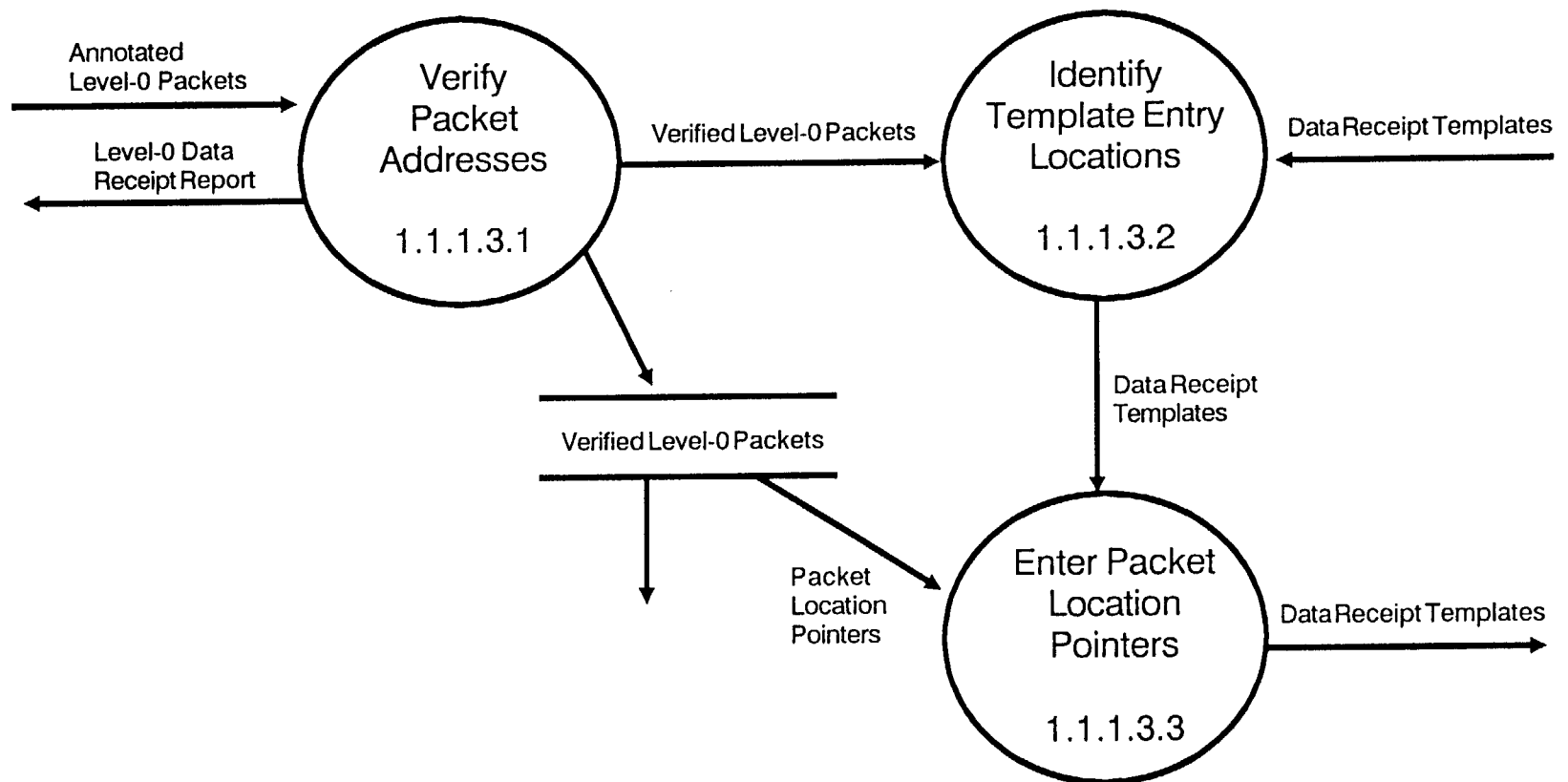
CONTROL PACKET ASSEMBLY PROCESS

DATAFLOW DIAGRAM (FUNCTION 1.1.1.2)

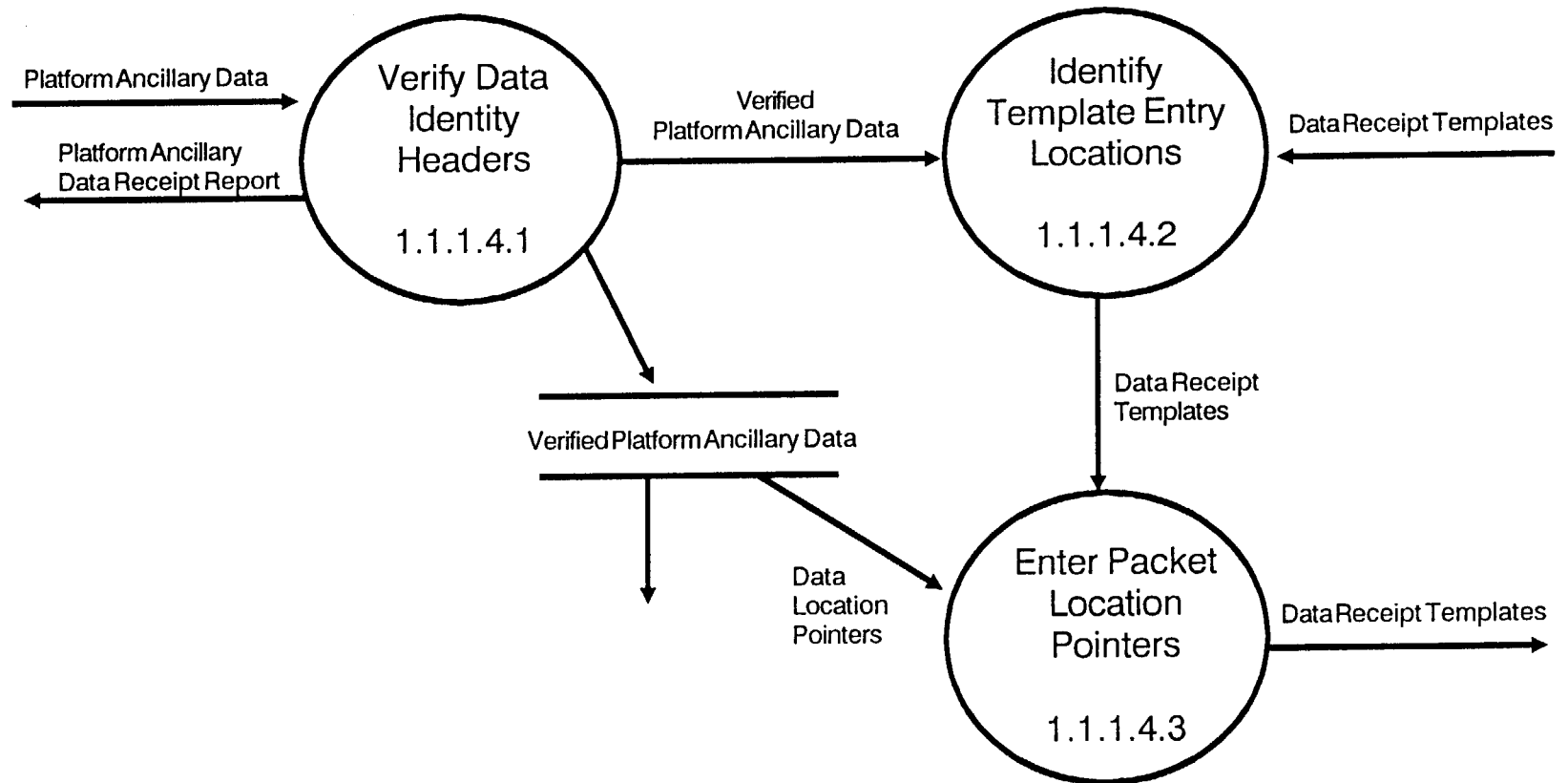


September 10, 1990

RECEIVE ANNOTATED LEVEL-0 DATA PACKETS DATA FLOW DIAGRAM (FUNCTION 1.1.1.3)



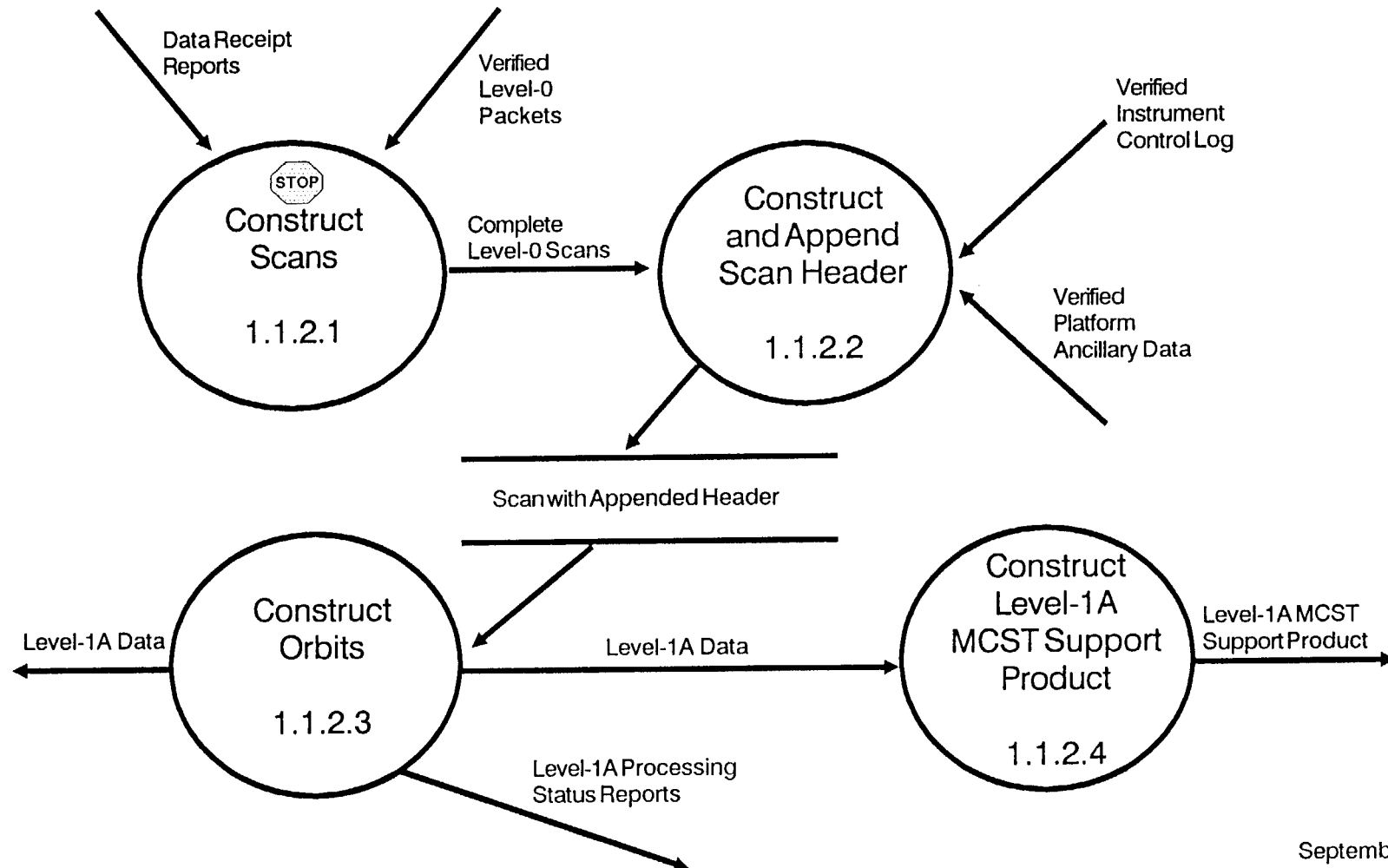
RECEIVE PLATFORM ANCILLARY DATA DATAFLOW DIAGRAM (FUNCTION 1.1.1.4)



September 11, 1990

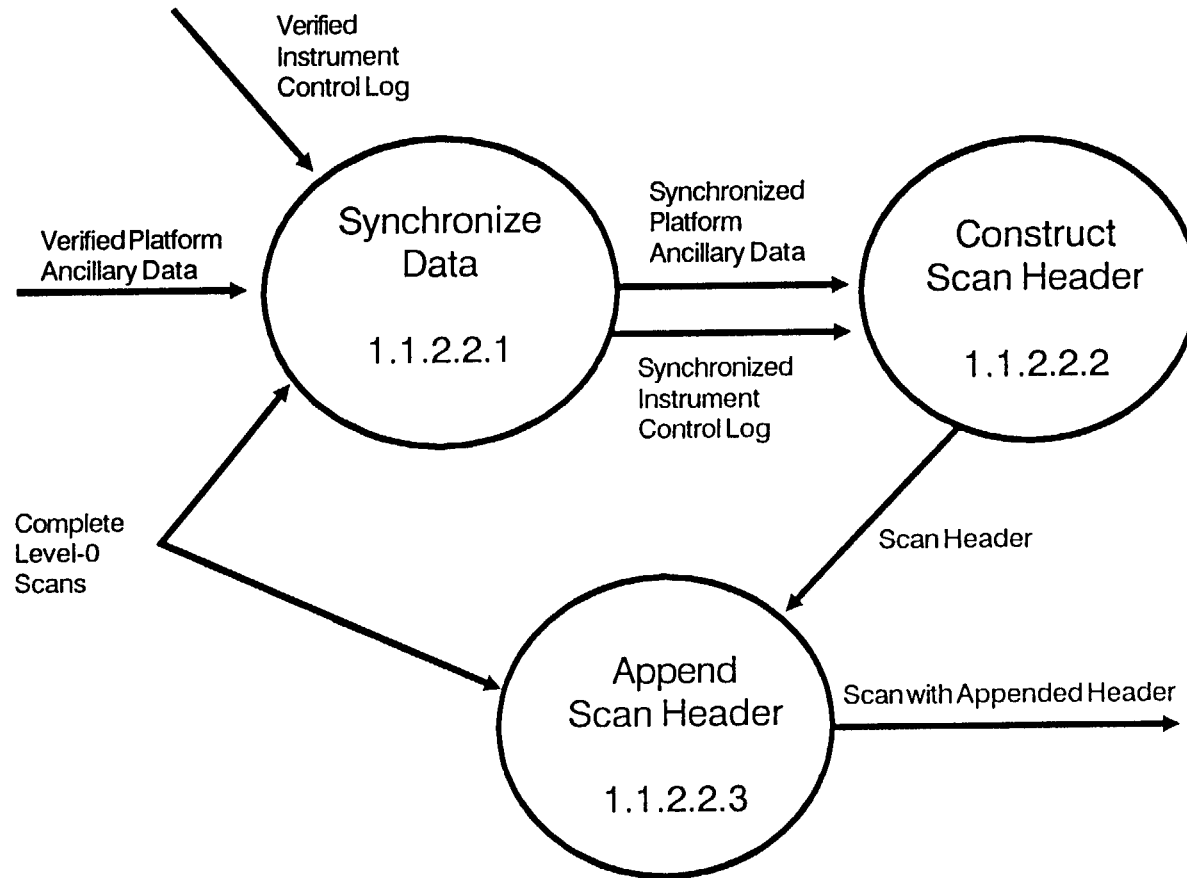
ASSEMBLE DATA

DATAFLOW DIAGRAM (FUNCTION 1.1.2)



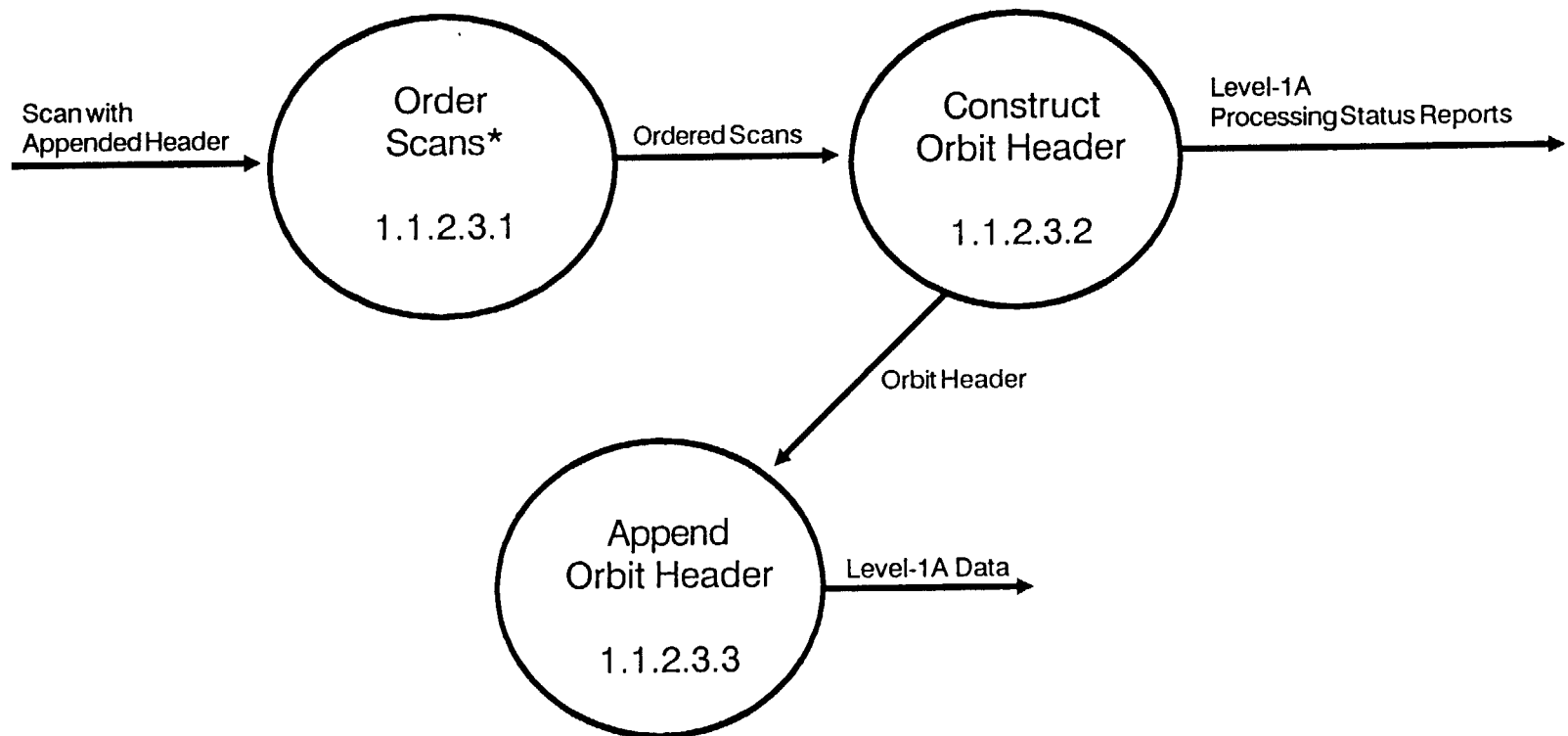
September 11, 1990

CONSTRUCT AND APPEND HEADER DATA FLOW DIAGRAM (FUNCTION 1.1.2.2)



CONSTRUCT ORBITS

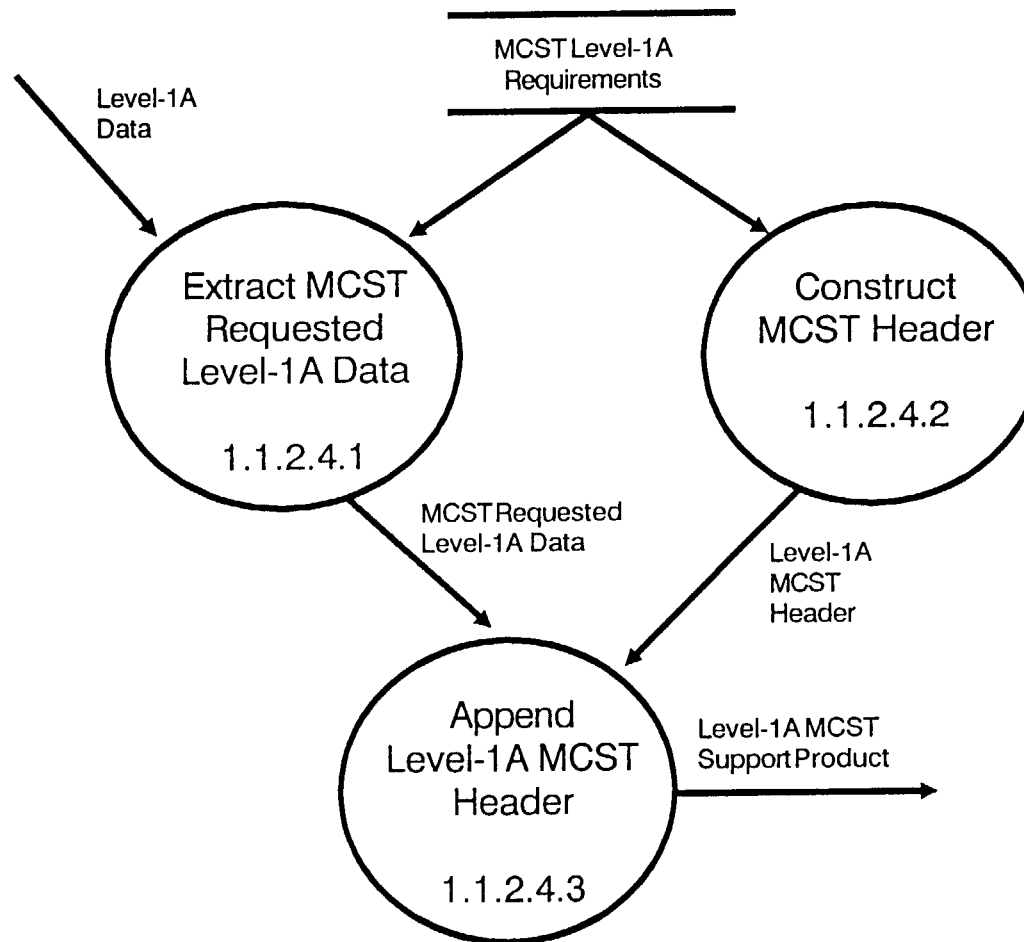
DATA FLOW DIAGRAM (FUNCTION 1.1.2.3)



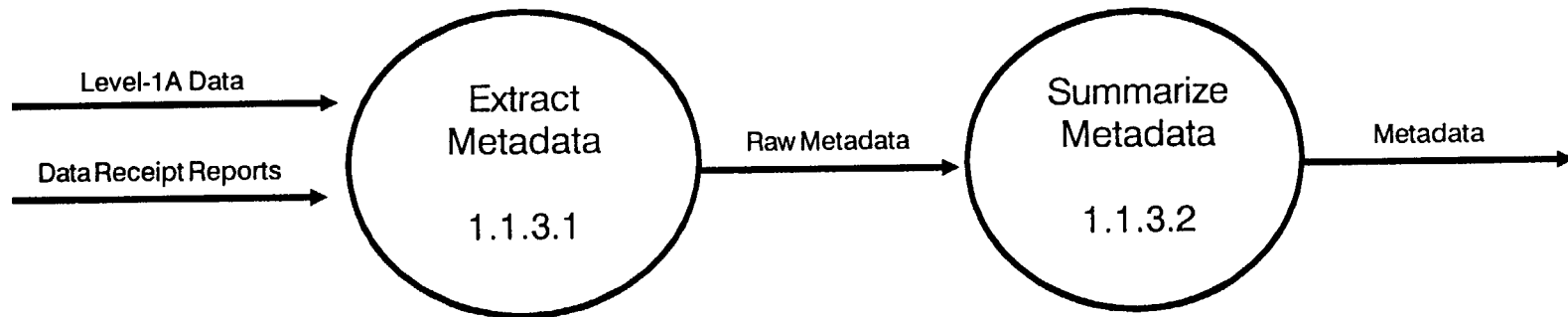
*Requirement uncertain; issue under discussion.

September 11, 1990

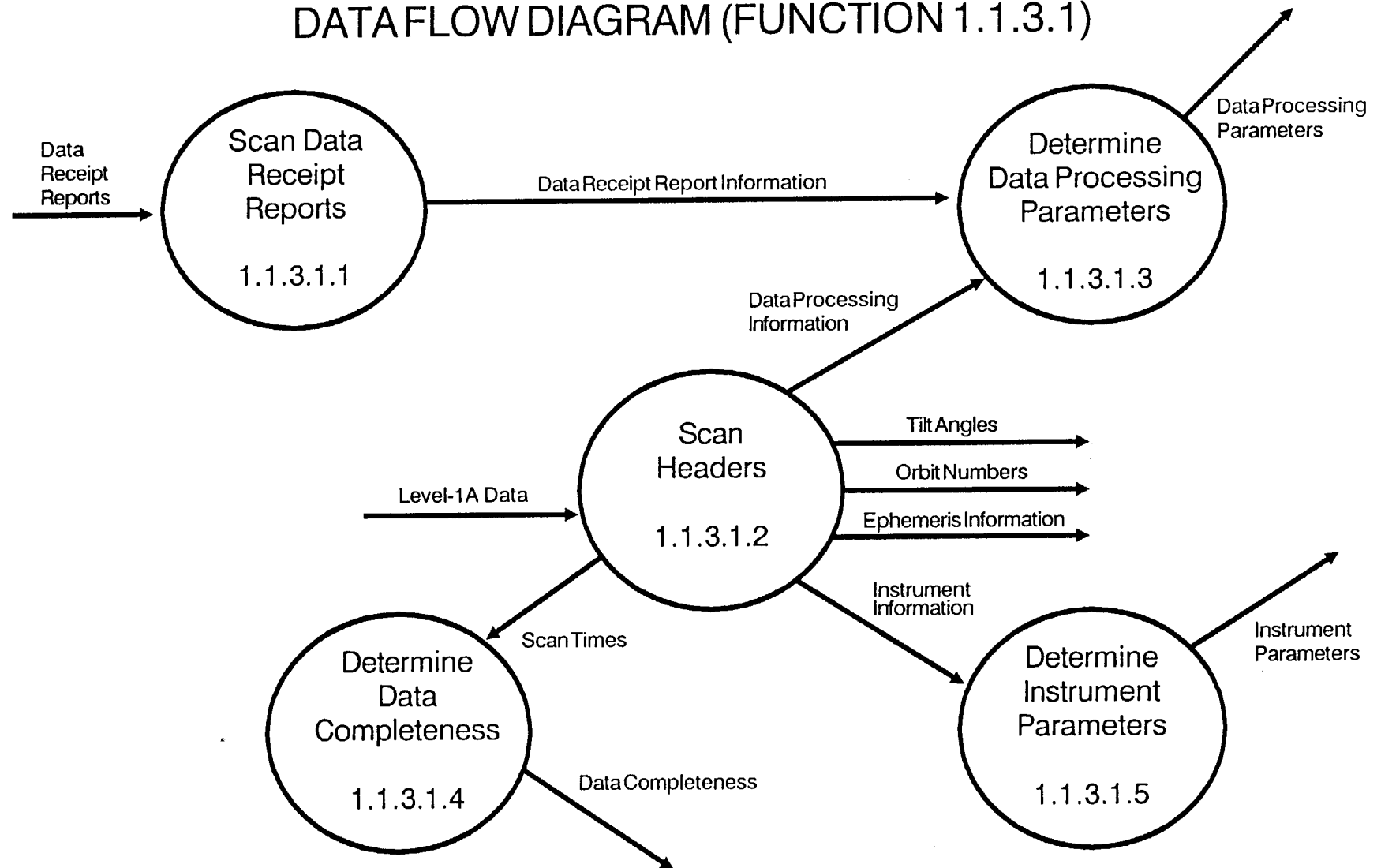
CONSTRUCT LEVEL-1A MCST SUPPORT PRODUCT DATAFLOW DIAGRAM (FUNCTION 1.1.2.4)



GENERATE LEVEL-1A METADATA
DATA FLOW DIAGRAM (FUNCTION 1.1.3)



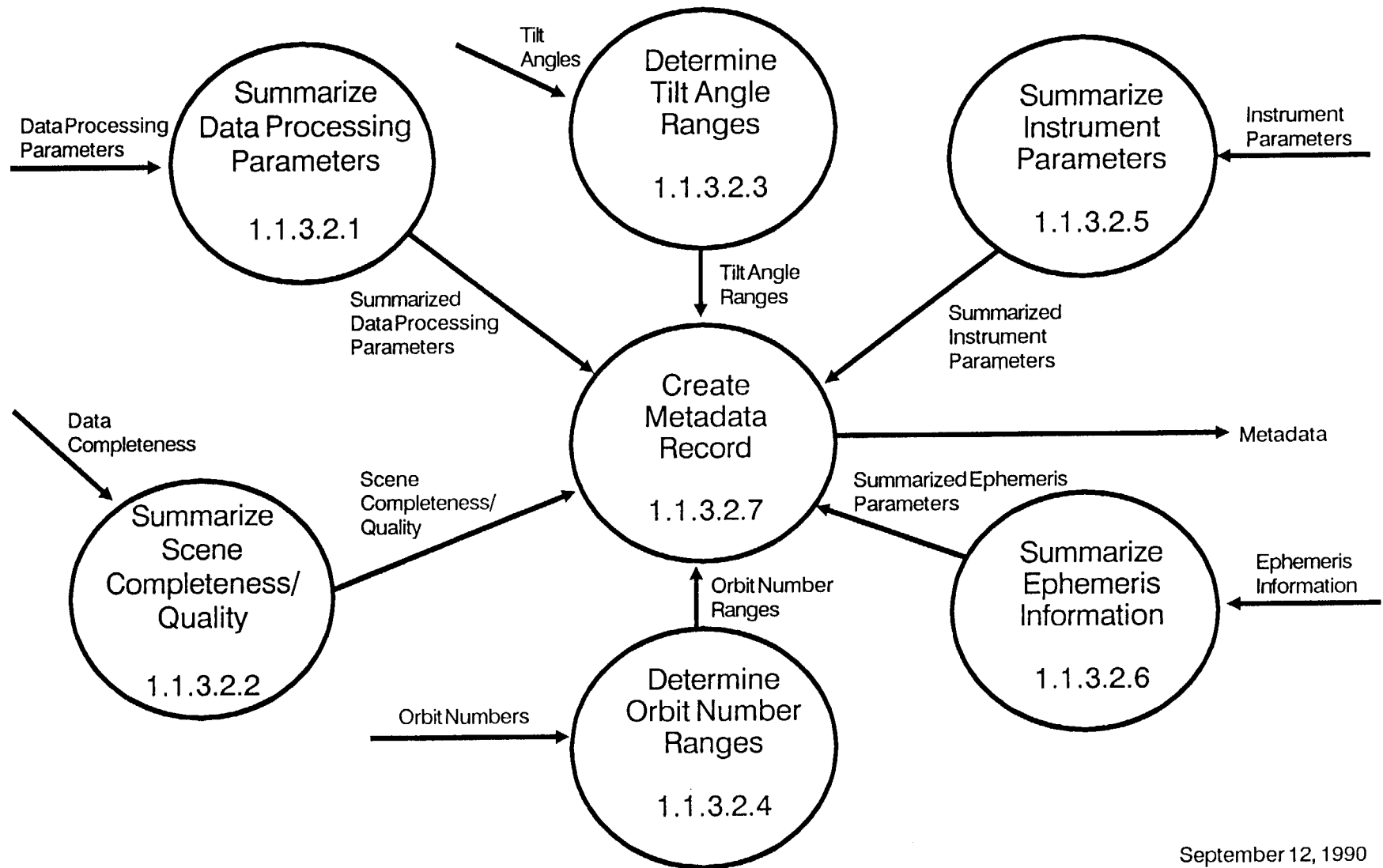
EXTRACT METADATA
DATAFLOW DIAGRAM (FUNCTION 1.1.3.1)



September 12, 1990

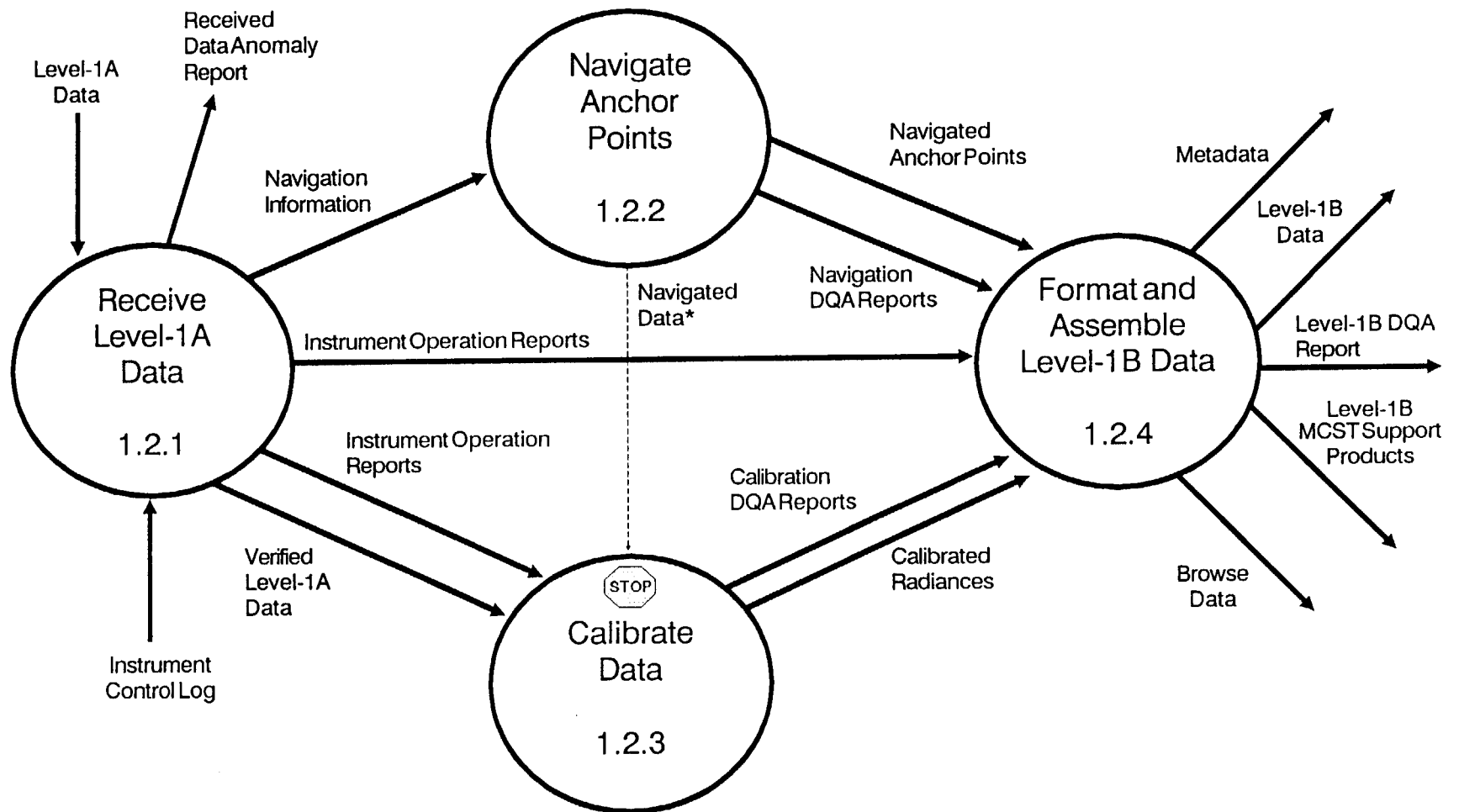
SUMMARIZE METADATA

DATAFLOW DIAGRAM (FUNCTION 1.1.3.2)



September 12, 1990

MODIS LEVEL-1B PROCESSING DATA FLOW DIAGRAM (FUNCTION 1.2)

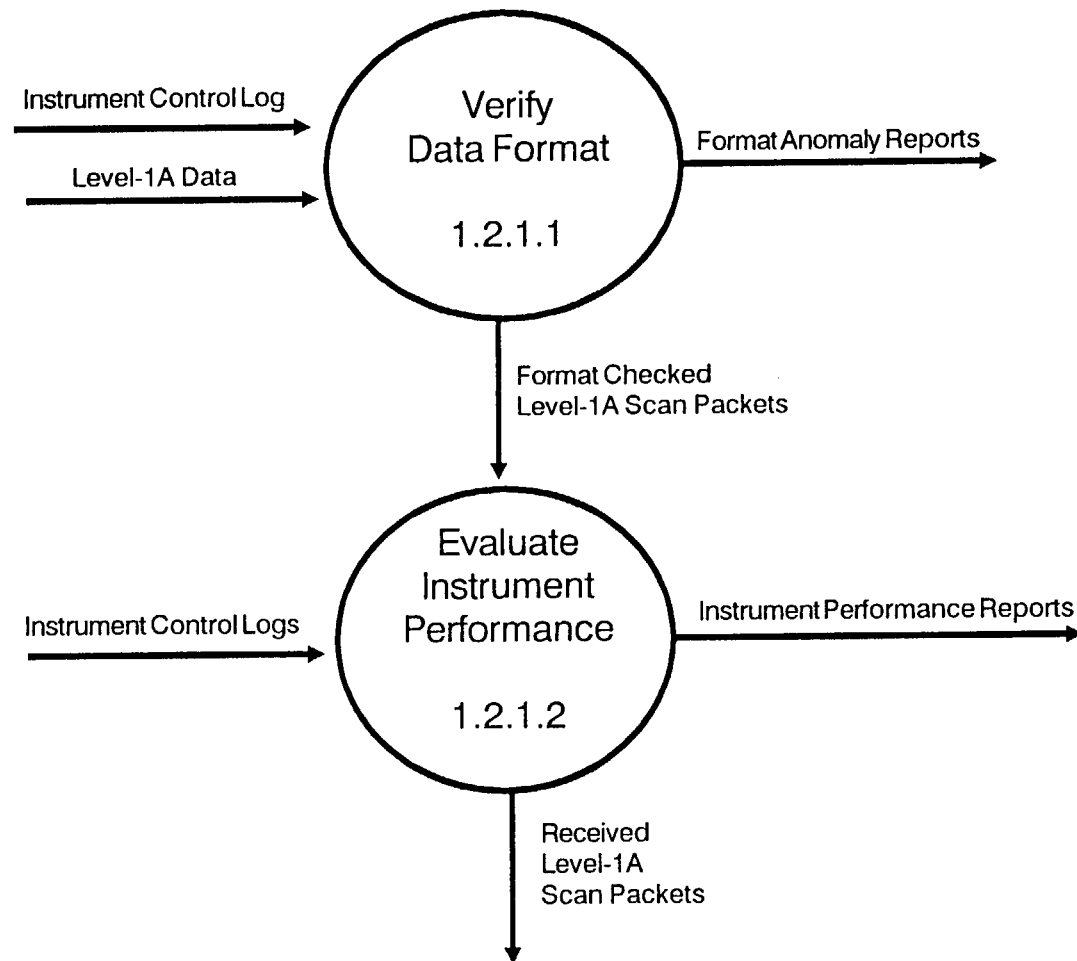


Denotes no further breakdown below this function.

*No present requirement; issue under discussion.

September 11, 1990

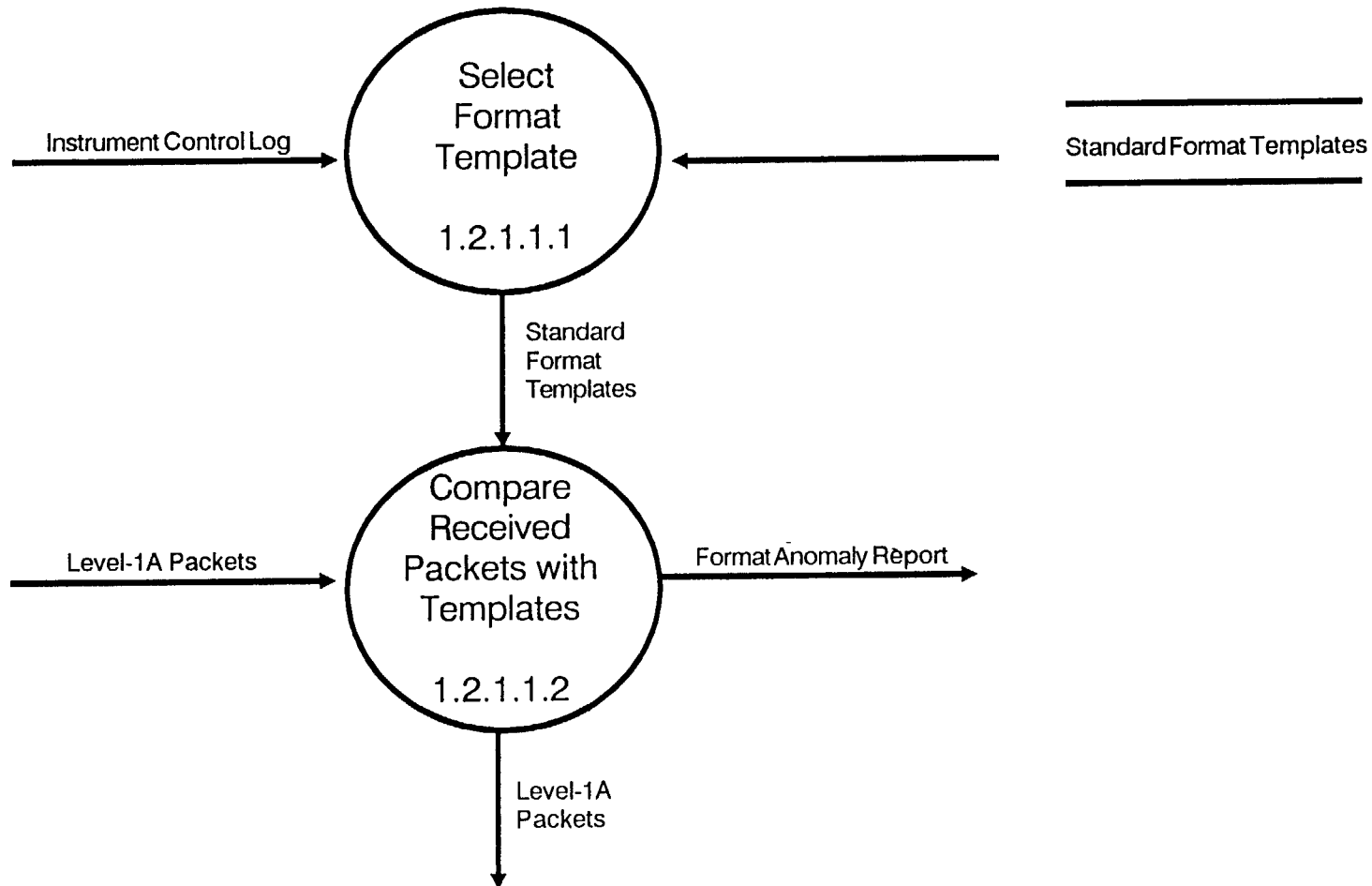
RECEIVE LEVEL-1A DATA
DATA FLOW DIAGRAM (FUNCTION 1.2.1)



September 11, 1990

VERIFY DATA FORMAT

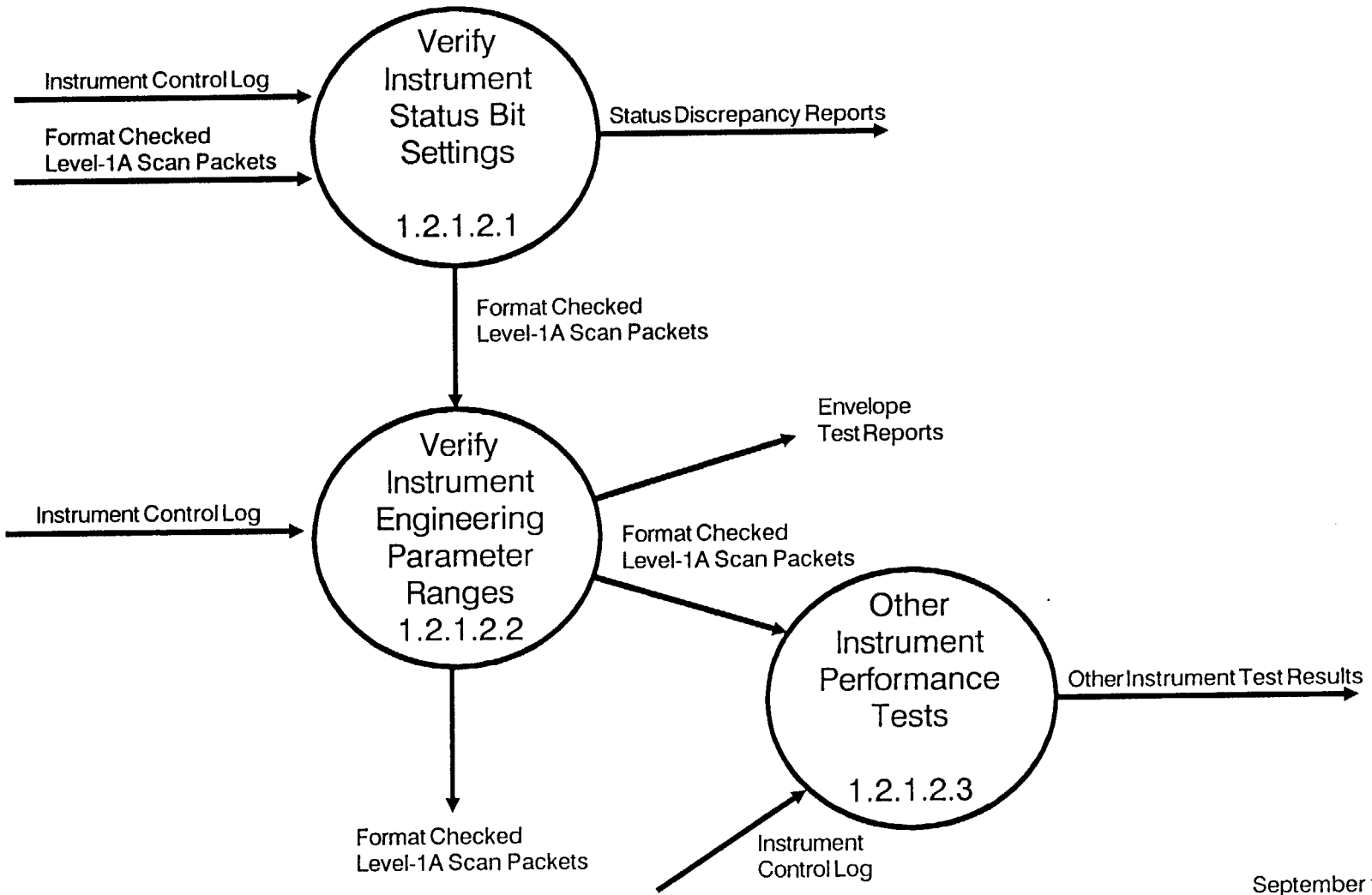
DATAFLOW DIAGRAM (FUNCTION 1.2.1.1)



September 10, 1990

EVALUATE INSTRUMENT PERFORMANCE

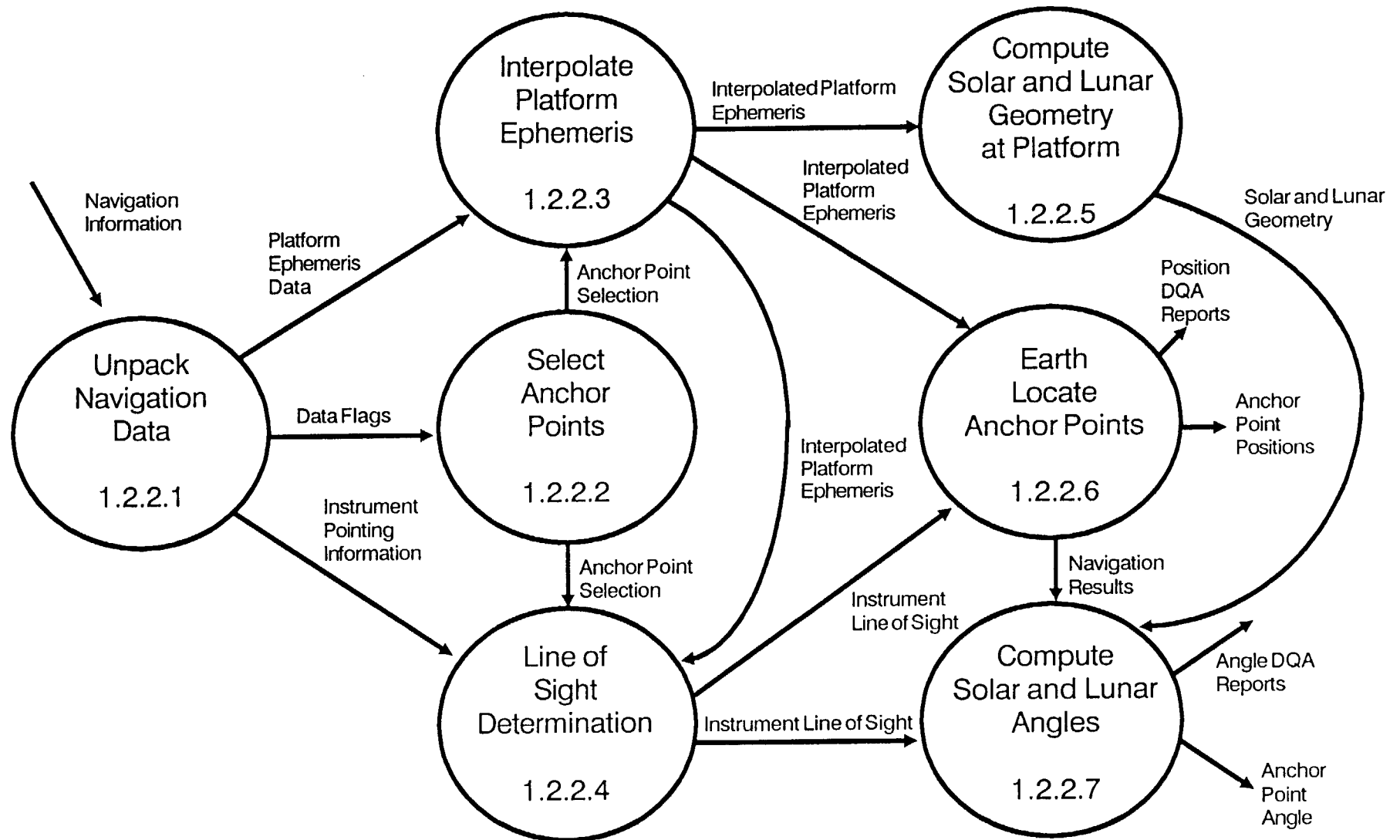
DATA FLOW DIAGRAM (FUNCTION 1.2.1.2)



September 10, 1990

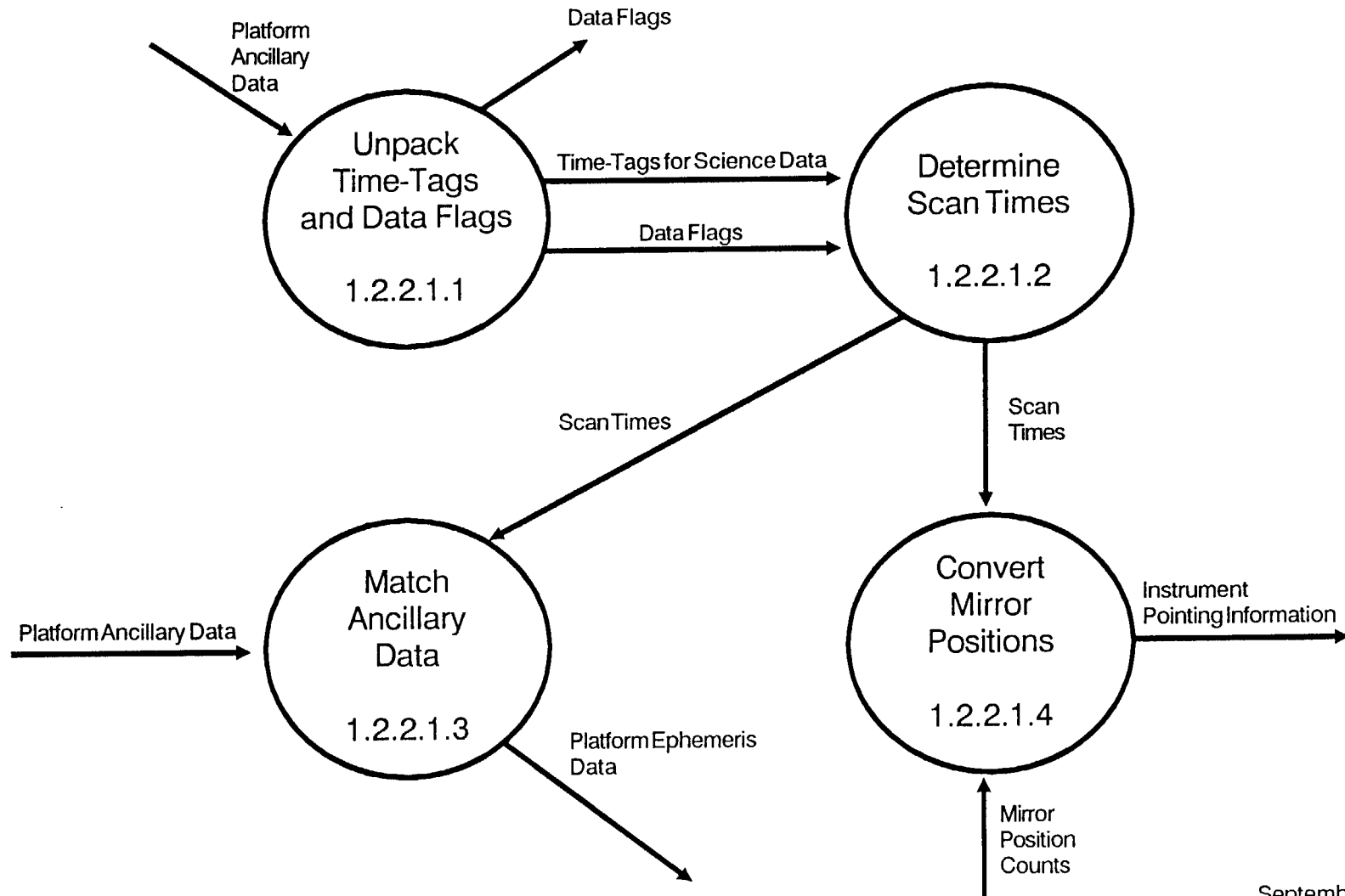
NAVIGATE ANCHOR POINTS

DATA FLOW DIAGRAM (FUNCTION 1.2.2)



UNPACK NAVIGATION DATA

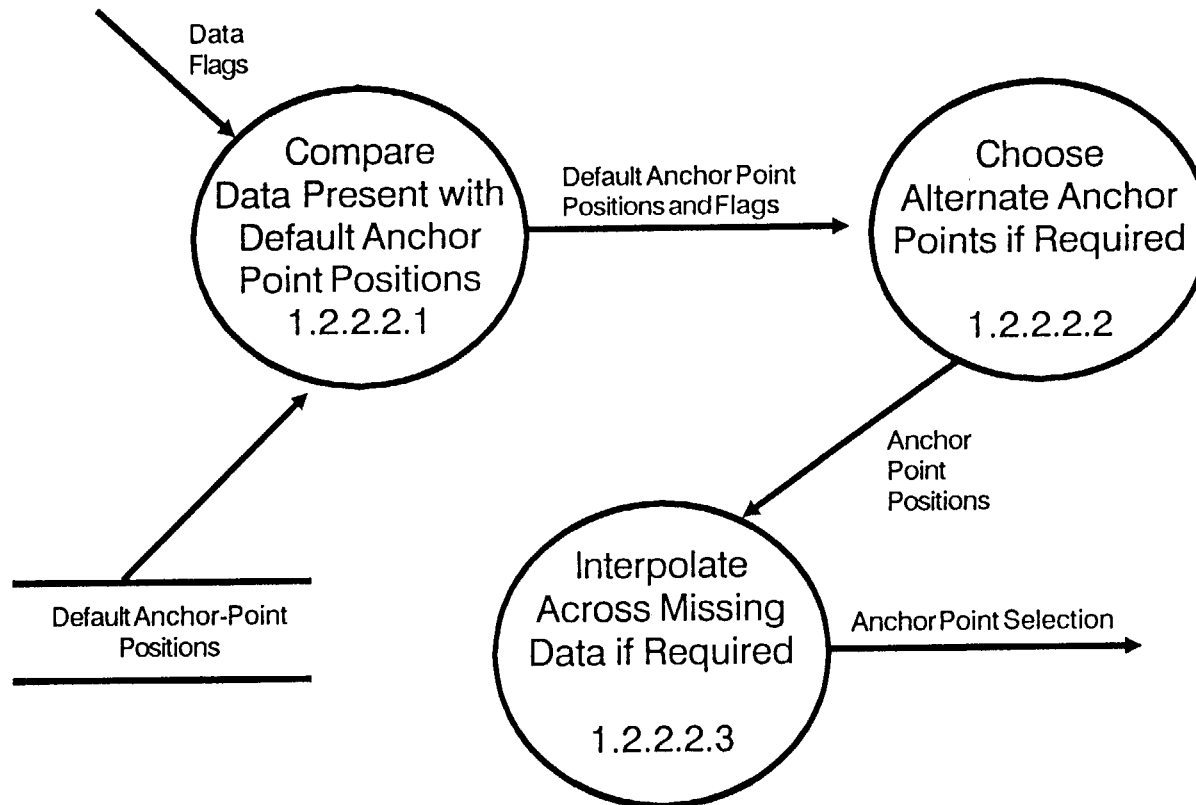
DATA FLOW DIAGRAM (FUNCTION 1.2.2.1)



September 9, 1990

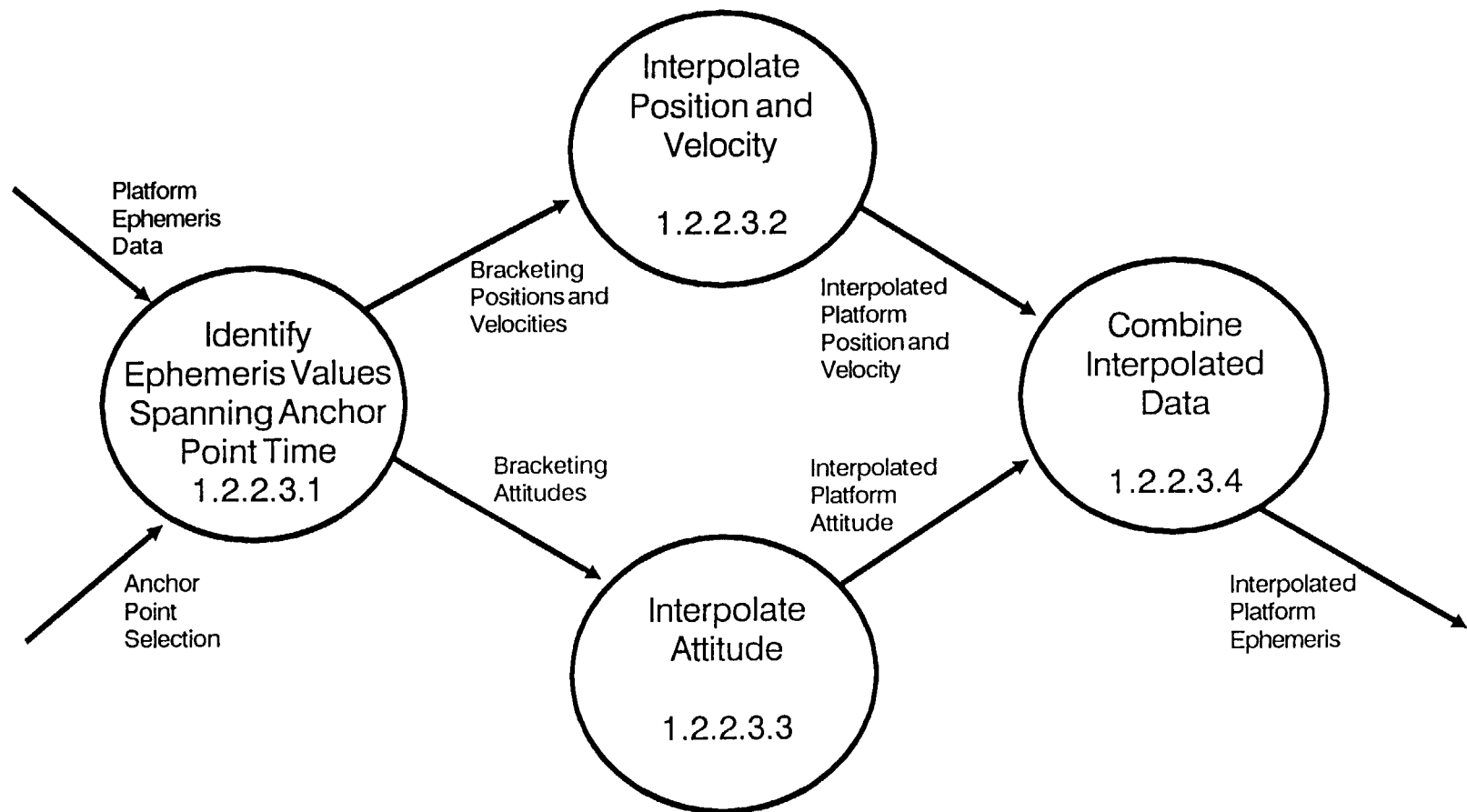
SELECT ANCHOR POINTS

DATA FLOW DIAGRAM (FUNCTION 1.2.2.2)



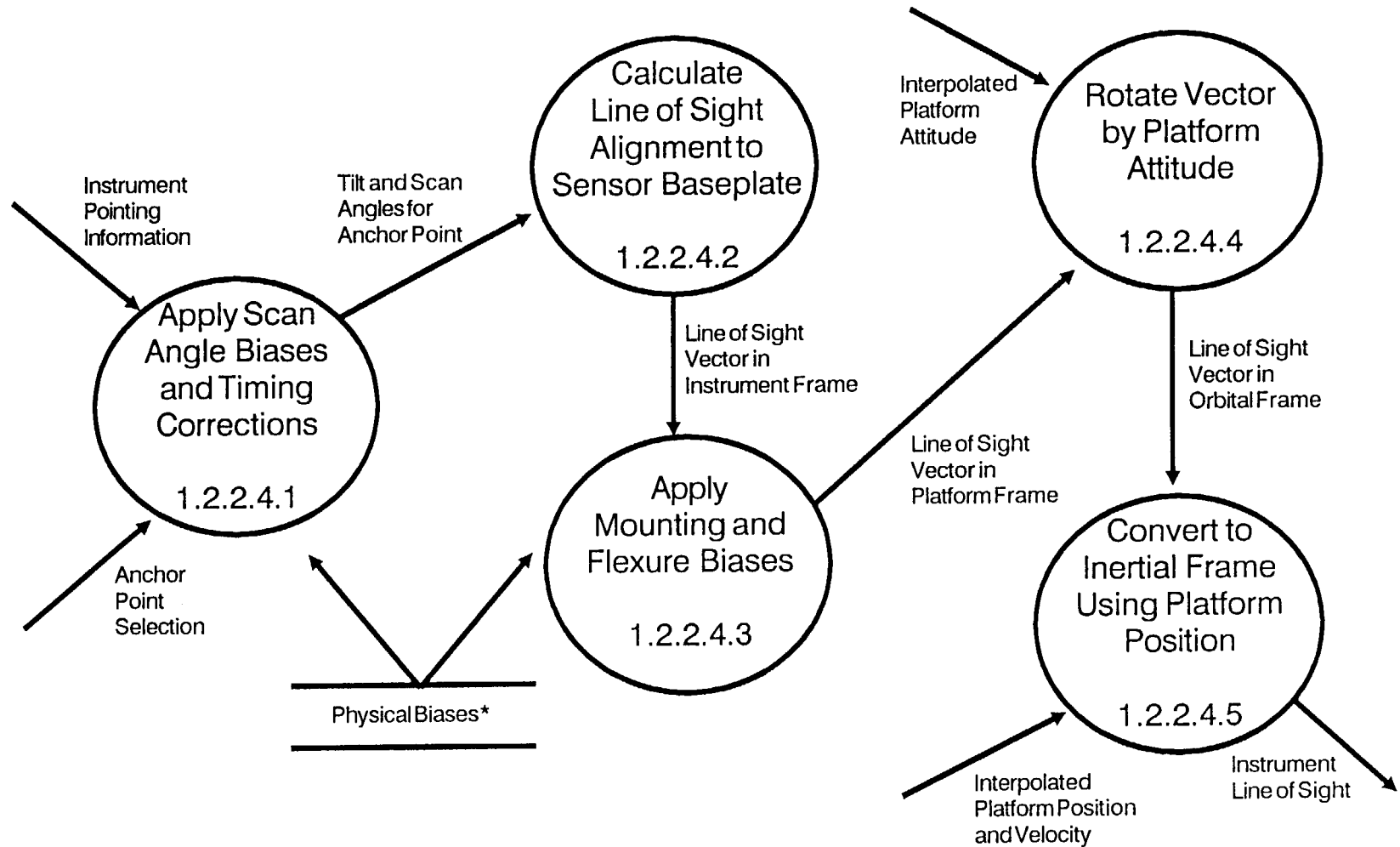
INTERPOLATE PLATFORM EPHEMERIS

DATA FLOW DIAGRAM (FUNCTION 1.2.2.3)



LINE OF SIGHT DETERMINATION

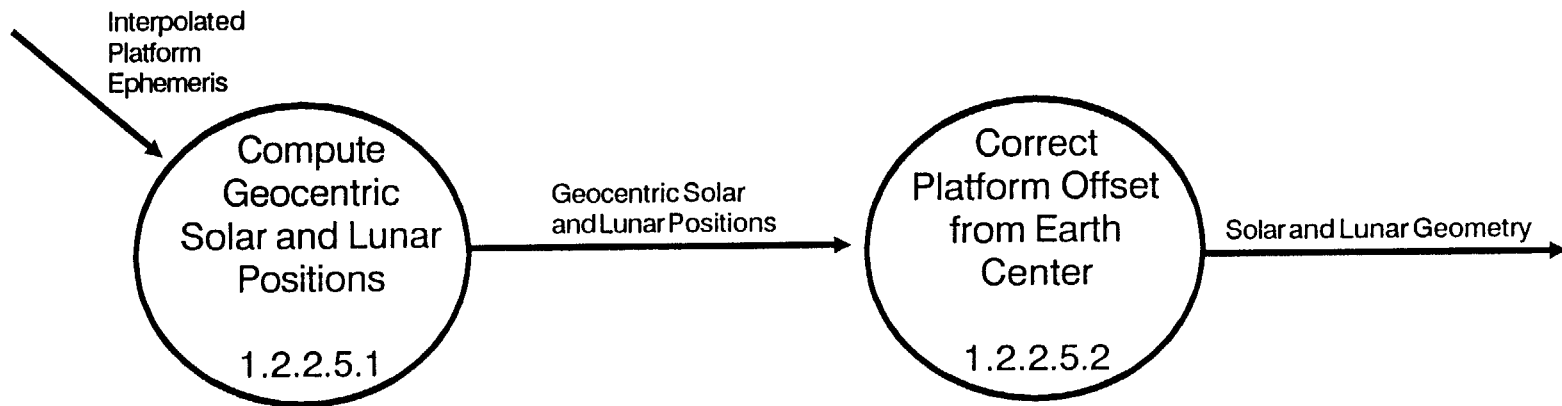
DATAFLOW DIAGRAM (FUNCTION 1.2.2.4)



*Internal file; not represented on higher-level diagrams.

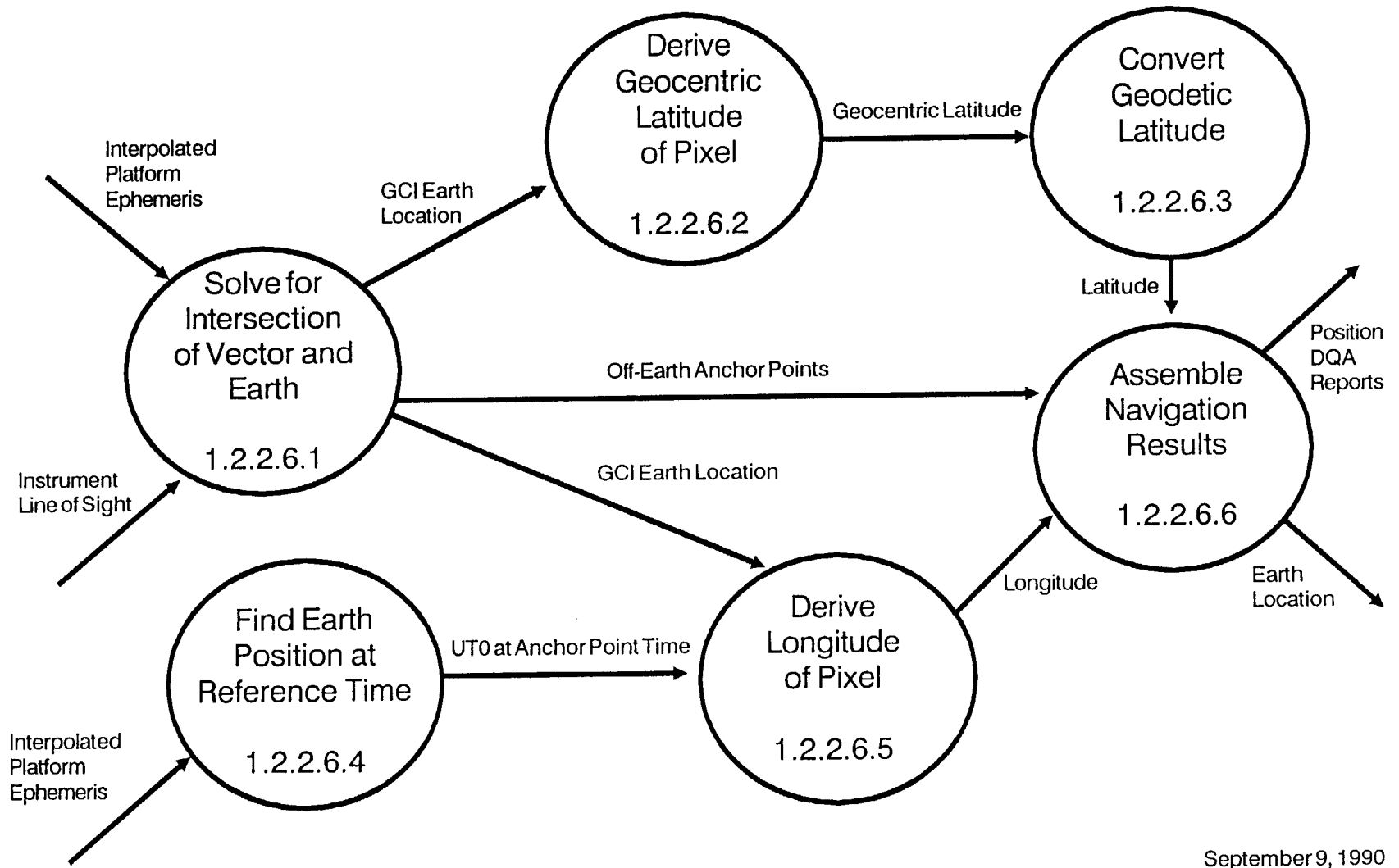
September 9, 1990

COMPUTE SOLAR AND LUNAR GEOMETRY AT PLATFORM DATAFLOW DIAGRAM (FUNCTION 1.2.2.5)



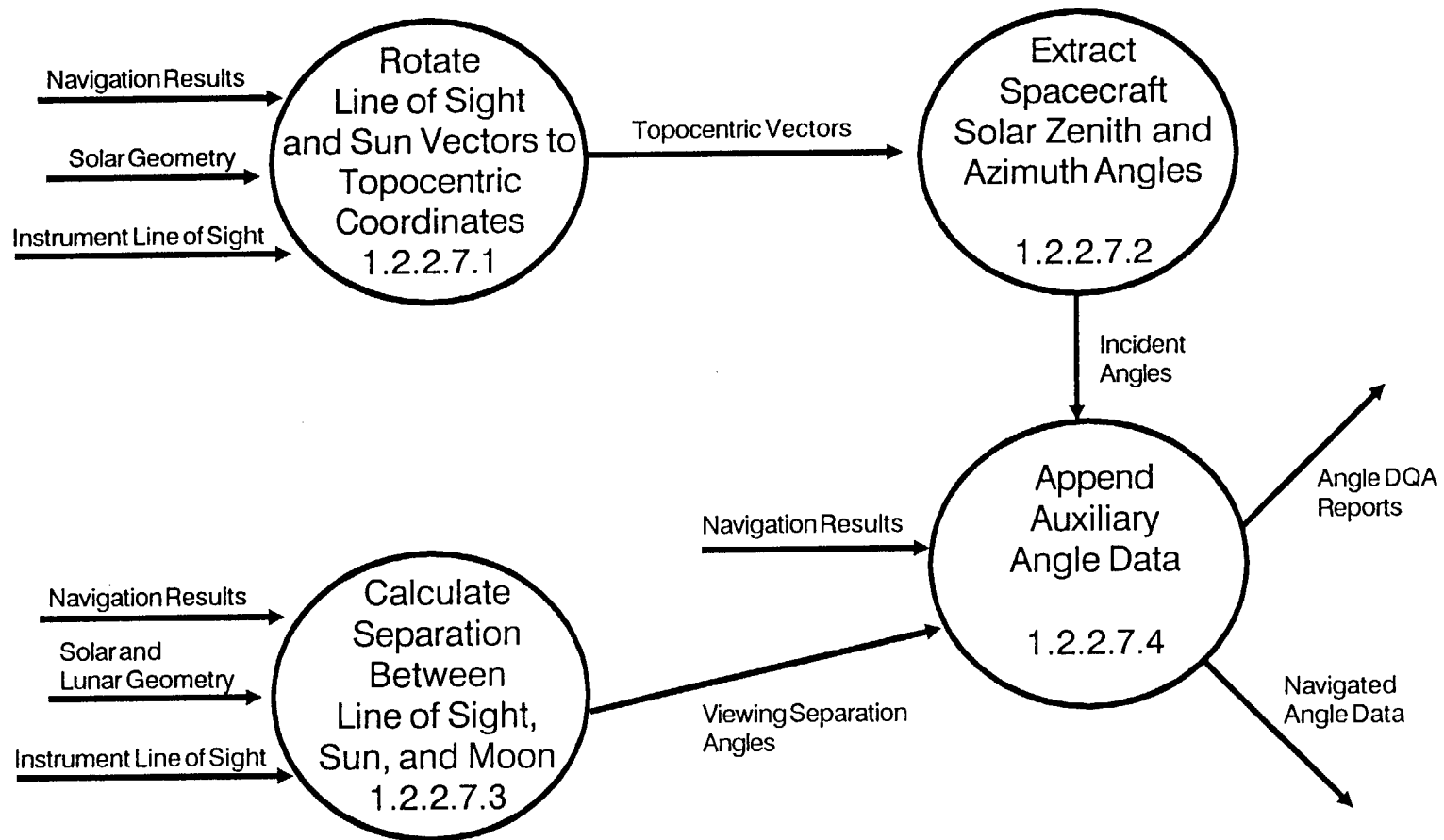
EARTH LOCATE ANCHOR POINTS

DATAFLOW DIAGRAM (FUNCTION 1.2.2.6)



September 9, 1990

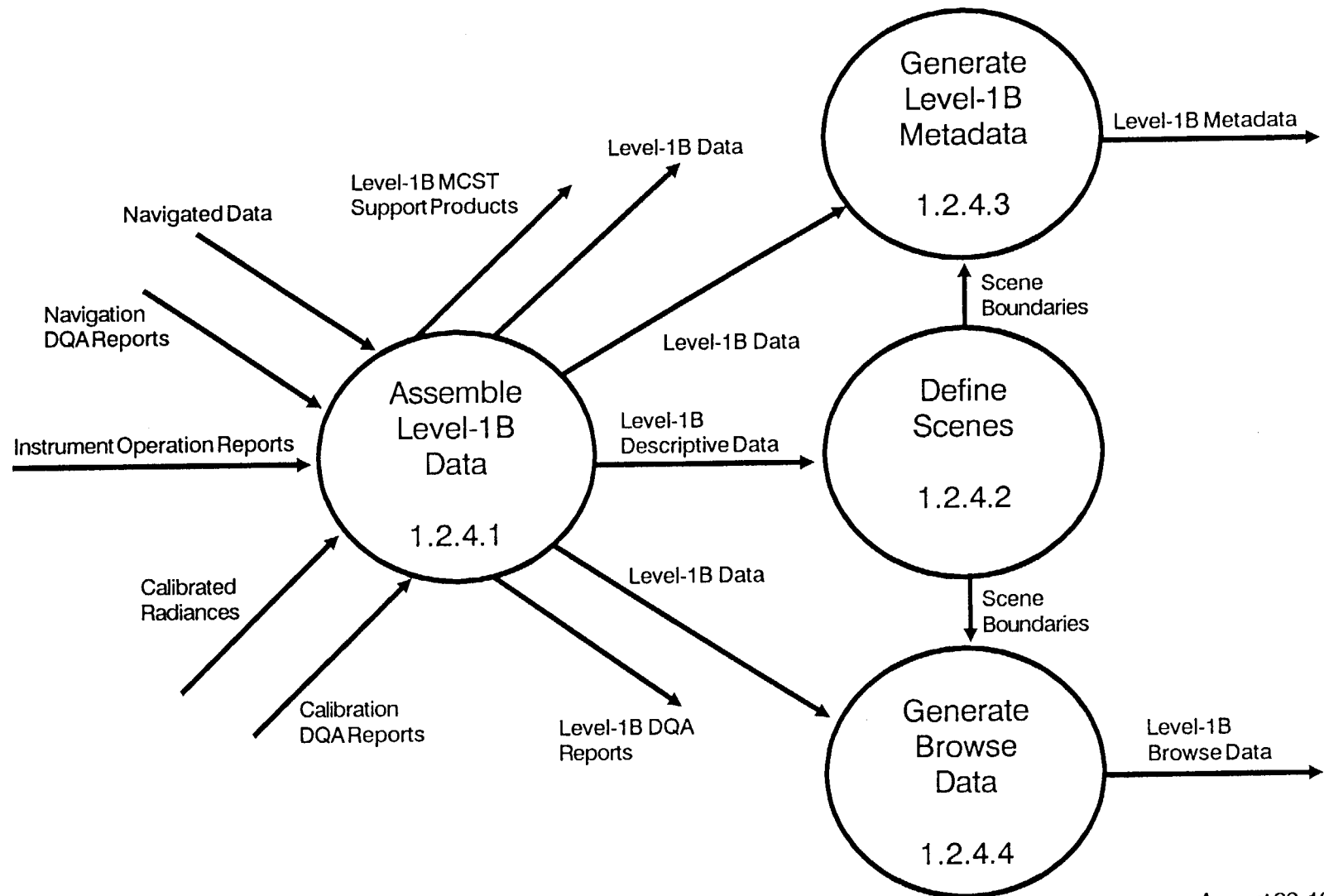
COMPUTE SOLAR AND LUNAR ANGLES DATAFLOW DIAGRAM (FUNCTION 1.2.2.7)



September 5, 1990

FORMAT AND ASSEMBLE LEVEL-1B DATA

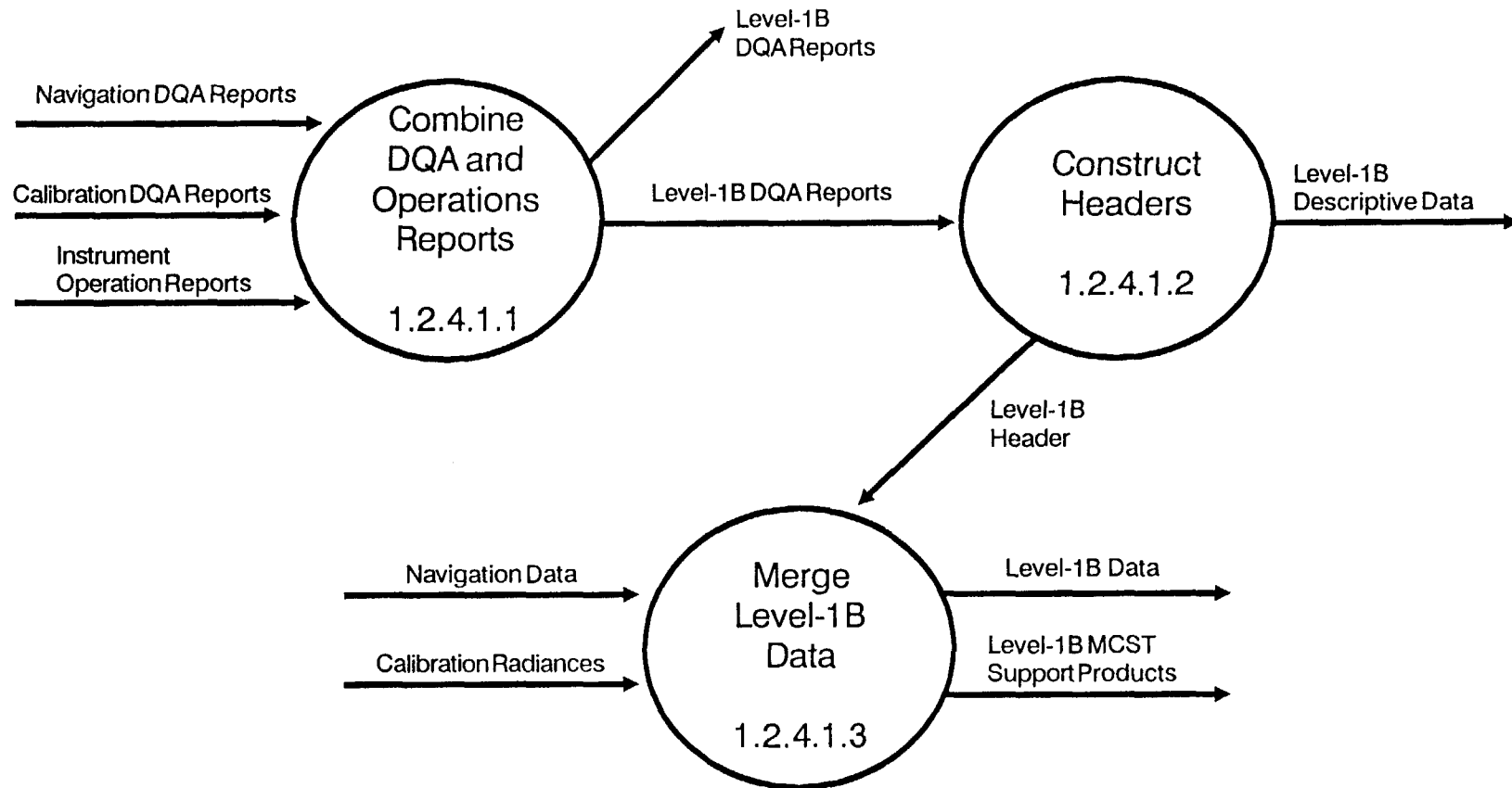
DATA FLOW DIAGRAM (FUNCTION 1.2.4)



August 22, 1990

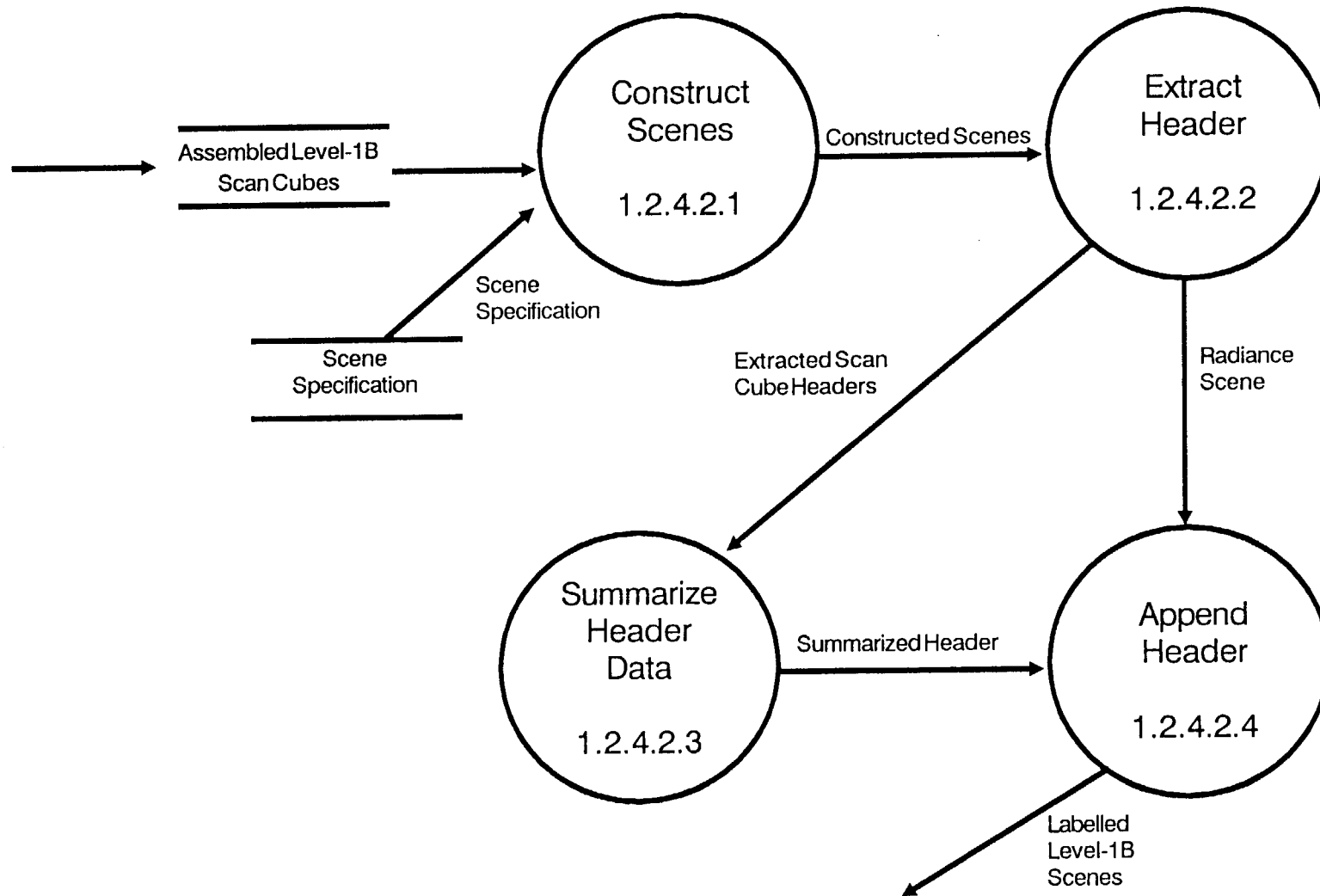
ASSEMBLE LEVEL-1B DATA

DATAFLOW DIAGRAM (FUNCTION 1.2.4.1)



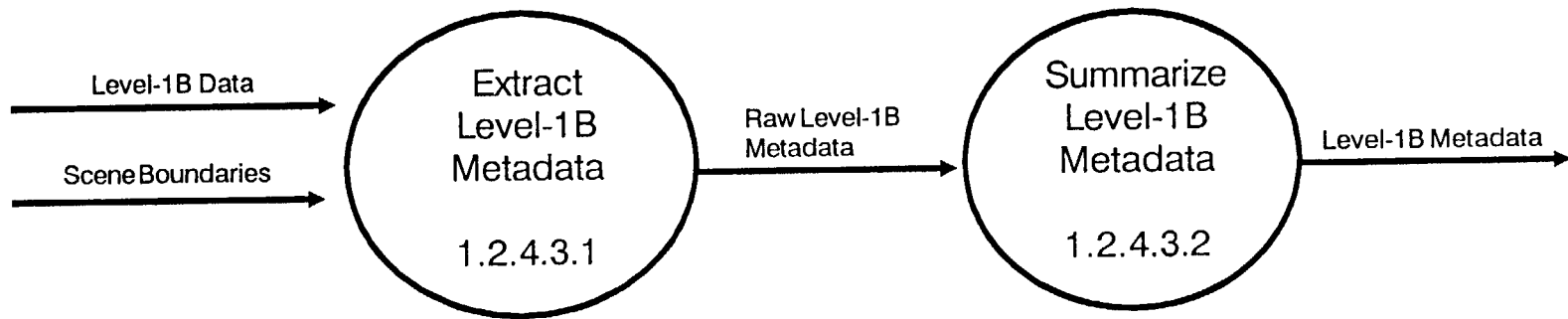
DEFINE SCENES

DATAFLOW DIAGRAM (FUNCTION 1.2.4.2)



GENERATE LEVEL-1B METADATA

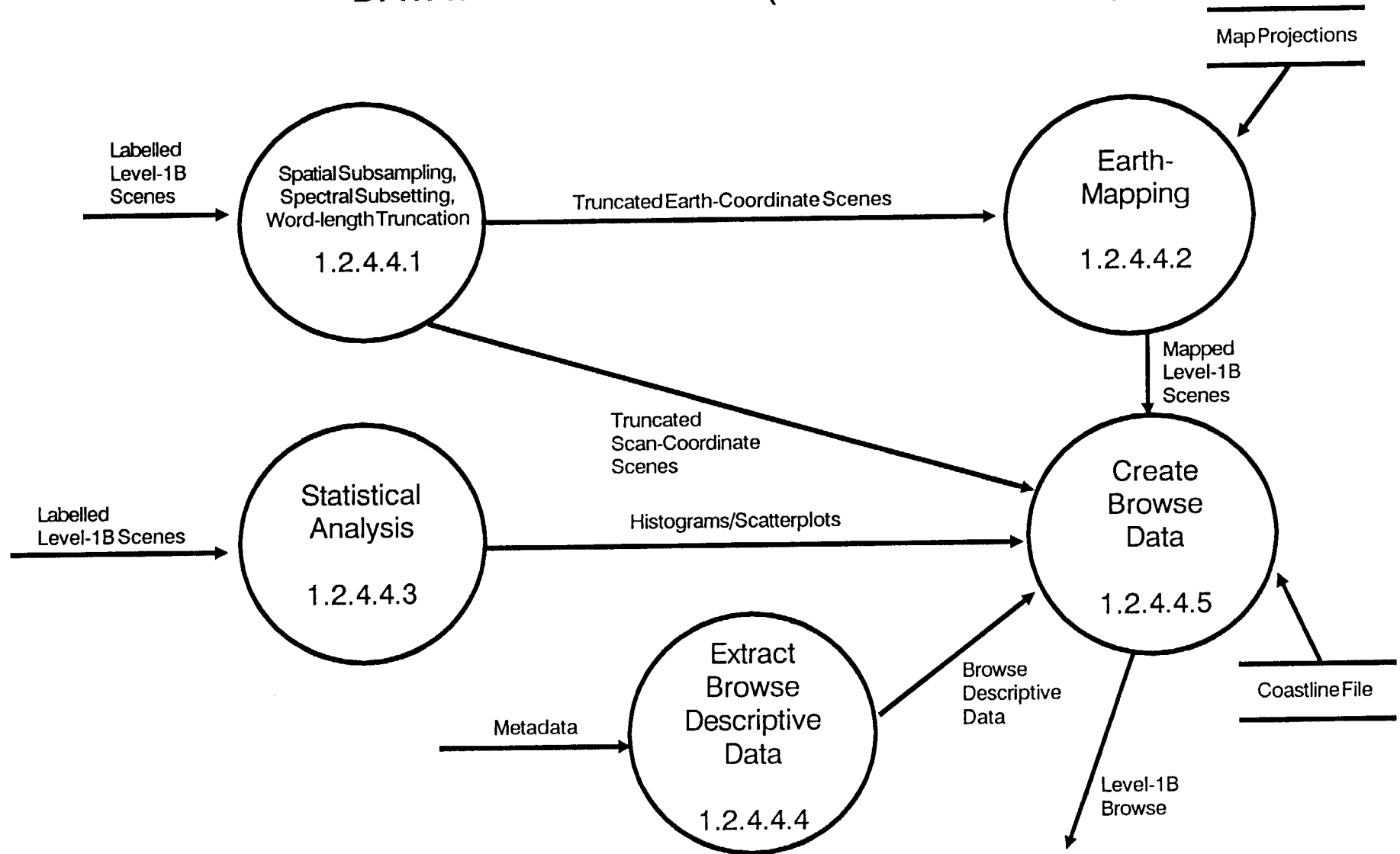
DATA FLOW DIAGRAM (FUNCTION 1.2.4.3)



September 12, 1990

GENERATE BROWSE DATA

DATAFLOW DIAGRAM (FUNCTION 1.2.4.4)



DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Anchor Point Angles	Solar zenith, satellite zenith, and relative azimuth for on-Earth anchor points or solar and lunar angles for off-Earth anchor points.
Anchor Point Positions	The selected anchor point pixel and line numbers.
Anchor Point Selection	The location within the scan of the selected anchor points (by pixel) and the associated times.
Annotated Level-0 Packets	MODIS Source Packets with appended accounting and data quality information as provided by CDOS. = Level-0 + Level-0 Annotation
Angle DQA Reports	Data quality assessment describing status and quality of instrument, terrestrial, lunar, and solar alignments.
Assembled Level-1B Scan Cubes	Blocks of data comprising along-track, across-track, and wavelength dimensions, with a header giving descriptive information about the cube, organized by time.
Bracketing Attitudes	Standard number of platform attitudes on each side of the anchor point time.
Bracketing Positions and Velocities	Standard number of platform positions and velocities on each side of the anchor point time.
Browse Data	Reduced spatial, spectral, and dynamic resolution data products routinely generated during MODIS processing to assist the ultimate data user in selecting MODIS data products suited to his needs.
Browse Descriptive Data	Data extracted from the metadata that contain useful information for browse data. Examples are tilt range, start/stop time, sensor identification, Earth coordinates of corner points.
Calibrated Radiances	Integrated results of radiometric and navigation activities.
Calibration Coefficients ¹	Numerical coefficients, parameters, or thresholds needed to apply the MODIS radiometric calibration using a Calibration Model.
Calibration DQA Reports	Data quality assessment describing status and quality of counts-to-radiance conversion.

¹No present requirement; issue under discussion.

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Calibration Model	An equation or set of equations and an algorithmic procedure used to convert instrument-generated digital counts to corresponding spectral radiances.
Coastline File	A file containing the latitudes and longitudes of coastlines.
Complete Level-0 Scans	Level-0 Scan completely filled with science data and with no default values.
Completed ² Packet Assembly Templates	Data Receipt Templates that have been completely filled in and therefore contain pointer information for all data required to assemble a scan packet, or that contains sufficient information that scan packet assembly can proceed given data timeliness constraints.
Constructed Scenes	Sets of complete MODIS scans beginning and ending at Earth-coordinate or scan-coordinate scene boundaries.
Data Completeness	Description of expected and missing data for the scan.
Data Flags	Flags indicating which portions of data for scan are present and any quality flags.
Data Processing Parameters	<ul style="list-style-type: none"> = Data Processing Level + Algorithm Documentation Location + Algorithm Version Number + Algorithm Name + Data Processing Location + Inventory data + Storage Media
Data Processing Information	= Data Processing Parameters
Data Receipt Reports	<ul style="list-style-type: none"> = Level-0 Data Receipt Report + Platform Ancillary Data Receipt Report + Instrument Control Log Data Receipt Report
Data Receipt Report Information	A digest and self-consistent summary of information contained in a group of data receipt reports destined for inclusion in metadata.

²The definition of completeness may be flexible and a function of elapsed time from observation.

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Data Receipt Templates	A template used to monitor receipt of Annotated Level-0 Data and Platform Ancillary Data and control the packet assembly process that generates Complete Level-1 Scans. One template is required for each Level-1 scan packet to be assembled. Each template contains a header that describes the contents of the associated packet, one field for each Annotated Level-0 Packet required to build a Level-1 scan packet, and one field for the Platform Ancillary Data associated with the scan packet. A completely filled-in template does not contain the actual Annotated Level-0 Packets or the actual Platform Ancillary Data but instead contains storage location pointers that point to the storage location of the required data. Templates are initially generated with the pointer fields set to the location of default fill packets to be used if required Annotated Level-0 Packets or Platform Ancillary Data is not received.
Data Request Dialog	= Level-0 Data Request + Level-0 Data Receipt Report
Default Anchor Point Positions	A stored set of ideal locations for the anchor points.
Default Anchor Point Positions and Flags	= Default Anchor Point Positions + Flags indicating whether suitable data are present for those pixels.
Earth Location	= Anchor Point Positions
Earth Model (file)	TBD geoid or ellipsoid; working design is standard ellipsoid.
Envelope Test Reports	Results of engineering parameter checks for the MODIS instruments.
Ephemeris Information	Predicted position on a weekly basis.
Extracted Scan Cube Headers	The headers that formerly belonged to the scan cubes, but which now have been separated from the count or radiance data of the scan cube.
Format Anomaly Reports	Results of format comparison tests that compare the format of received MODIS data with a format template for expected data.
Format Checked Level-1A Scan Packets	Level-1A data.
GCI Earth Location	X, Y, Z coordinates of selected pierce point in GCI.

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Geocentric Latitude	The angle formed by the vector from the center of the Earth to the pierce point and the equatorial plane.
Geocentric Solar and Lunar Positions	Positions for Sun and Moon in GCI for one time during scan. Motion is slow enough to require only one determination per scan.
Histograms/Scatterplots	Graphic screens or windows statistically describing the information content of MODIS scenes designed for browse purposes.
Incident Angles	Spacecraft and Sun zenith and azimuth angles as seen from pixel.
Instrument Control Log	A list of planned and actual events affecting the operational status of a MODIS instrument and associating a beginning time with each event.
Instrument Control Log Receipt Report	A report that informs the IMS that nominal Instrument Control Log data received appears to be valid or appears to be invalid and retransmission is required.
Instrument Engineering Telemetry	= Calibration Data + Instrument-Specific Data + Other Instrument-Specific Hardware Performance/Status Information
Instrument Housekeeping Telemetry	= Temperature + Power Relay On/Off Status + Instrument Input Voltage + Instrument Input Current
Instrument Information	= Instrument Parameters
Instrument Line of Sight	Vector in GCI describing the direction that MODIS was looking when anchor point was observed.
Instrument Operation Reports	= Format Anomaly Reports + Instrument Performance Reports
Instrument Parameters	= Instrument Operation Mode + Sensor ID + Instrument Configuration + Platform ID
Instrument Performance Reports	= Status Discrepancy Reports + Envelope Test Reports + Other Instrument Test Reports

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Instrument Pointing Information	Mirror positions and time tags.
Instrument Telemetry	= Instrument Housekeeping Telemetry + Instrument Engineering Telemetry
Interpolated Platform Attitude	Platform attitude at the anchor point time.
Interpolated Platform Ephemeris	= Interpolated Platform Position and Velocity + Interpolated Platform Attitude
Interpolated Platform Position and Velocity	Platform position and velocity at the anchor point time.
Labelled Level-1B Scenes	A grouping of Level-1B scan cubes containing a header describing the data in the scene. There may be several formats. At the highest level, these scenes will be organized into time-ordered scan (satellite) coordinates and time-ordered Earth coordinates.
Latitude	Geodetic latitude of pixel.
Level-0	Instrument-Data at original resolution, time order restored, with duplicates removed.
Level-0 Annotation	= CDOS-appended completeness and transmission quality/error decoding indicators.
Level-0 Data Receipt Report	Results of the packet address check for Annotated Level-0 Packets delivered to the IMS for control purposes.
Level-0 Data Request	A request that directs the ECS (DADS?) to retrieve and transmit all available Annotated Level-0 Packets with acquisition times between a start time and stop time specified in the request.
Level-1 Processing Status Reports	= Level-1A Processing Status Reports + Level-1B Processing Status Reports
Level-1A	Level-0 data which may have been reformatted or transformed reversibly, located to a coordinate system, and packaged with needed ancillary, engineering, and auxiliary data.
Level-1A MCST Header	Information about the attributes of standard, non-standard, or data products for the Level-1A MCST products.
Level-1A MCST Support Product	MCST Support Products generated on physical medium for distribution as a part of Level-1A processing.

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Level-1A Packets	Scan packets of Level-1A data.
Level-1A Processing Status Reports	Information on the performance of Level-1A data processing.
Level-1B	Level-1A data to which the radiometric calibration algorithms have been applied, to produce radiances or irradiances and to which the Earth-location and navigation algorithms have been applied.
Level-1B Browse	*Browse images and plots based on statistical analyses/data compression to facilitate selection and ordering of Level-1B data.* = Level-1B Browse Images + Level-1B Browse Plots
Level-1B Images	Calibrated radiance data sets that have been spatially sub-sampled, spectrally sub-setted, and word-length truncated, created and stored for graphic display to aid the user in selection and ordering of data and DQA. The browse data sets will include selected descriptive information from the metadata. Browse images will be organized into scenes along several formats, conforming to the scene definition.
Level-1B Browse Plots	Statistical information on radiance data scenes that facilitate understanding of the data, to aid in selection and ordering of data and DQA. These statistical analyses shall include histograms and scatterplots, and selected descriptive information from the metadata.
Level-1B Descriptive Data	Position and scan-related information to be used in defining scenes at Level-1B for browse and metadata generation purposes.
Level-1B DQA Reports	= Navigation DQA Reports + Calibration DQA Reports + Instrument Operations Reports
Level-1B Header	Completeness, quality, and other information required to describe each MODIS Level-1B scan.
Level-1B MCST Support Product	MCST Support Products generated on physical medium for distribution as a part of Level-1B processing.
Level-1B Metadata	Integrated descriptive information characterizing MODIS Level-1B scenes for product evaluation and ordering purposes.

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Level-1B Processing Status Reports	= Level-1B DQA Reports
Line of Sight Vector in Instrument Frame	Vector in instrument frame describing direction that MODIS was looking when anchor point was observed.
Line of Sight Vector in Orbital Frame	Vector in orbital frame describing direction that MODIS was looking when anchor point was observed.
Line of Sight Vector in Platform Frame	Vector in platform frame describing direction that MODIS was looking when anchor point was observed.
Longitude	Earth location, angle from prime meridian.
Lunar Geometry	Moon vector from platform for one time during scan.
Mapped Level-1B Scenes	Level-1B scenes that have been mapped into Earth coordinates.
Map Projections	A file containing algorithms for computing map projections, used for re-sampling satellite-coordinate data into geo-referenced data.
MCST Level-1A Requirements	Definition of the Level-1A functional and performance elements for the MCST.
MCST Requested Level-1A Data	Basic MODIS Level-1A information meeting MCST acquisition requirements.
MCST Support Products	<p>*A data set containing selected MODIS digital counts and radiance data fields, and other relevant information. This product is routinely generated at the behest of the MODIS Characterization Support Team (MCST) and contains requested data items³.*</p> <p>= Level-1A MCST Support Products + Level-1B MCST Support Products</p>
Metadata	<p>*Descriptive data developed during MODIS product generation to support user selection of MODIS data products using the facilities of the Information Management Center (IMC).*</p> <p>= Level-1A Metadata + Level-1B Metadata</p>

³Is this product to be permanently retained? Should it be generated directly at the MCST without involving the Product Generation Facility? What operating modes will the MODIS instruments support? How many calibration modes are there? How will data from other instrument operating modes that do not include science data collection be stored? For example, will the instrument have an instrument test mode?

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Mirror Position Counts	Raw values indicating the scan angle of the rotating mirror.
Missing Data Descriptors	= Missing Data Type Designators + Missing Data Start Times + Missing Data Stop Times
Navigated Anchor Points	*The Earth location of the anchor points, if any; the solar and spacecraft zenith and azimuth at the pixel; for off-Earth pixels, separation of line of sight vector from Sun and Moon.* = Anchor Point Positions + Anchor Point Angles
Navigated Angle Data	= Anchor Point Angles
Navigated Data	= Anchor Point Angles + Anchor Point Positions
Navigation DQA Reports	= Angle DQA Reports + Position DQA Reports
Navigation Information	= Platform Ancillary Data + Mirror Position Counts + Time-Tags + Level-1A Data Flags
Navigation Results	The Earth location of the anchor point, if any.
Off-Earth Anchor Points	Pixels in scan which miss the Earth.
Orbit Header	Information about the attributes of standard, non-standard, or data products for an orbit.
Orbit Number Ranges	Maximum and minimum orbit number associated with processed data at any level.
Orbit Numbers	Measured starting at ascending node, it is a sequential number which represents the number of times that the satellite has circled the Earth.
Ordered Scans	Scans which are organized to be grouped into orbits of data.
Other Instrument Test Results	Results of previously undesignated performance evaluation tests for the MODIS instruments.
Packet Location Pointers	A data storage address that indicates the address of the first word in a stored data block.

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Physical Biases (file)	Sensor mounting biases (and launch shifts); platform flexure biases; timing errors; mirror alignment offsets; and other TBD.
Platform Ancillary Data	Platform location and attitude data used to navigate and monitor MODIS pixel locations, and other platform housekeeping data needed for Level-1 and higher processing ⁴ = Standard Platform-Generated Ancillary Data + Instrument Telemetry
Platform Ancillary Data Receipt Report	Results of the data identity check for Platform Ancillary Data delivered to the IMS for control purposes.
Platform Ancillary Data Request	A request that directs the ECS (DADS?) to retrieve and transmit all available Platform Ancillary Data records with acquisition times between a start time and stop time specified in the request.
Platform Ephemeris	= Platform Position + Platform Velocity + Platform Attitude + Platform Time
Position DQA Reports	= Data quality assessment describing status and quality of Earth-located anchor points.
Processing Parameters	= Processing State Parameters + Processing Schedule Parameters
Processing Schedule Parameters	The maximum allowable elapsed time since data acquisition before an incomplete scan packet is forwarded for further processing "as is", i.e. with data items missing.
Processing State Parameters	Attributes used to select Instrument Control Log data to be used in current processing.
Radiance DQA Reports	= Data quality assessment describing status and quality of calibrated MODIS radiances and the counts-to-radiance conversion process.
Radiance Scene	A scene containing Level-1B radiance data, without a header.

⁴Will a chronology of platform events (maneuvers, service interruptions, etc.) be available? Where will the platform event chronology be developed? Should the platform chronology be integrated with the corresponding record for the MODIS instrument (Instrument Command and Response History)? Should a chronology of platform events be integrated into the mainstream of MODIS data (Level-1A)? Should status data from other payload instruments also be appended to MODIS Level-1A data? Are other platform data items needed in the MODIS Level-1A record?

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Raw Level-1B Metadata	Basic descriptive information characterizing MODIS Level-1B scenes for product evaluation and ordering purposes.
Raw Metadata	Basic descriptive information characterizing MODIS Level-1A scenes for product evaluation and ordering purposes.
Received Data	A complete set of Level-0, Ancillary Platform, and Calibration Coefficient data that remains after data quality verification procedures are applied and inappropriate data are rejected. Received Level-0 data blocks have been entered in a Level-0 data receipt record.
Received Data Anomaly Report	= Format Anomaly Reports + Instrument Performance Reports
Received Level-1A Scan Packets	Level-1A data.
Scan Header	Information about the attributes of standard, non-standard, or data products for a scan.
Scan Information	Scan times plus Data Flags.
Scan Times	Start and end times for scan.
Scan with Appended Header	Scans of MODIS Level-1A data with scan headers appended, but not yet organized into orbits (with orbital headers).
Scene Boundaries	= Level-1B Descriptive Data
Scene Completeness/Quality	Description of expected and missing data for the scene.
Scene Specification	Stored data containing the start/stop times, and Earth locations required to create scenes. These specifications are read into the Level-1 data processing flow to determine how Level-1 scenes will be created.
Selected Platform Ancillary Data	The position, velocity, and attitude of the platform with their time-tags and time conversion information for a scan duration.
Solar and Lunar Geometry	Sun and Moon vectors from platform for one time during scan. Motion is slow enough to require only one determination for each scan.
Solar Geometry	Sun vector from platform for one time during scan.
Standard Format Templates	Templates indicating format check items for the various operating modes of the MODIS-N and MODIS-T instruments.

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
Standard Platform-Generated Ancillary Data	= Platform Ephemeris + Other Platform-Generated Ancillary Data
Status Discrepancy Reports	Results of status bit checks for the MODIS instruments.
Summarized Data Processing Parameters	Statistics on data processing parameters which occurred during processing at Level-1A. At higher levels it consists of all data processing parameters associated with the data that were processed by the previous operation.
Summarized Ephemeris Parameters	Statistics concerning ephemeris parameters that were used when processing and orbit of data.
Summarized Header	
Summarized Instrument Parameters	Statistics on instrument parameters which occurred in processed data.
Synchronized Instrument Control Log	Instrument Control Log data matched in time to complete Level-0 scans.
Synchronized Platform Ancillary Data	Platform Ancillary Data matched in time to complete Level-0 scans.
Tilt and Scan Angles for Anchor Points	For each anchor point, the value of the tilt angle (pitch) and scan angle (roll) for the sensor with respect to the sensor mounting.
Tilt Angle Ranges	Maximum and minimum tilt angles in orbit (or granule).
Tilt Angles	MODIS-T pointing information for a single scan.
Time-Tags for Science Data	Times identifying when data were taken.
Topocentric Vectors	Vectors to spacecraft and Sun in local coordinate system at pixel.
Truncated Earth-Coordinate Scenes	Scenes for which spatial sub-sampling, spectral sub-setting, and word-length truncation have been applied, organized into time-ordered, Earth coordinates (latitude, longitude).
Truncated Scan-Coordinate Scenes	Scenes for which spatial sub-sampling, spectral sub-setting, and word-length truncation have been applied, organized into time-ordered, satellite coordinates (along-track, across-track).

DICTIONARY DEFINING LEVELS OF PROCESSING OF MODIS DATA	
DATA ITEM	DATA DEFINITION
UT0 at Anchor Point Time	Time in system synchronized with Earth rotation (corrects for irregular rotation rate)
Verification Findings	Results of the data identification test for Instrument Control Log data.
Verified Instrument Control Log	Instrument Control Log data as transmitted by the ICC with data failing the header address examination removed from the data stream.
Verified Level-0 Packets	Annotated Level-0 Packets as transmitted by the ECS (DADS?) with data failing the packet address test (non-MODIS data) removed from the data stream.
Verified Level-1A Data	Level-1A data.
Verified Platform Ancillary Data	Platform Ancillary Data as generated by the ECS in response to Platform Ancillary Data Requests but with incorrectly-sent data removed from the data stream.
Viewing Separation Angles	Angular separation between line of sight and Sun and Moon vectors, to see if MODIS is observing either.